POWER PLANT ENGINEERING

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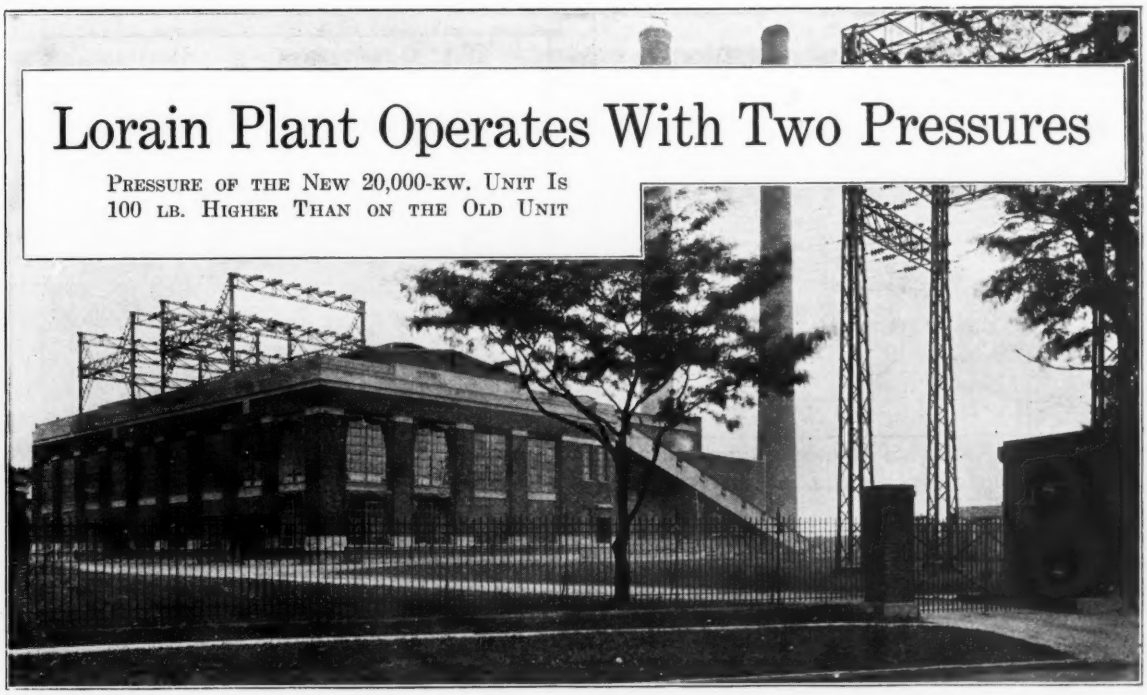


Lorain Plant Operates With Two Pressures

PRESSURE OF THE NEW 20,000-KW. UNIT IS 100 LB. HIGHER THAN ON THE OLD UNIT

IN JULY OF 1919, the new Edgewater Station of The Lorain County Electric Co. was placed in operation. This station, located on the south shore of Lake Erie at Lorain, Ohio, was expected to take care of the demand for power in and around Lorain. The plant was designed for an ultimate capacity of 60,000 kw., the first unit consisting of one 8000-kw. (10,000-kv.a.), 3-phase, 60-cycle, 6600-v., 1800-r.p.m. Westinghouse high pressure condensing steam turbine which was supplied with steam by six standard 512-hp. Stirling S-26 water-tube boilers operated at a working pressure of 200 lb. per sq. in.

In the fall of 1921, the various properties of The Cities Service Co. located in northeastern Ohio were consolidated into one company known as The Ohio Public Service Co. and plans were immediately made to connect these properties with a 135,000-v. loop. The stations connected with the Lorain plant are located at Warren, Alliance, Massillon and Mansfield, Ohio. These four stations were operating under maximum conditions because of lack of water facilities due to their inland location and it was therefore decided to take care of any additional power requirements from the Edgewater power station. Accordingly, in October of 1922 ground was broken at Lorain for an additional unit of 20,000-kw. capacity.

Coal from eastern Ohio mines is delivered to this plant by the B. & O. Railroad Co. and it is either put into coal storage at the plant or dropped into concrete coal hoppers which feed directly to a Robbins standard 30 by 36-in. two-roll crusher. This crusher operates at a speed of about 120 r.p.m. and coal is fed by gravity through the crusher to a Robbins 20-in. belt conveyor, which in turn delivers the coal to bunkers located over the firing aisle. From these bunkers, the coal passes down through five stationary coal scales, and from there through spreaders to the stoker hoppers. Narrow gaged V-shaped dump cars carry the ash to the storage pit which is located in the rear of the plant. The ash is then hoisted by a coal crane to standard gage cars and put into overhead storage. The ash cars are at present handled by man power, but it is planned to purchase a small storage battery or superheated steam locomotive.

The original Stirling boilers were designed to operate at 200 lb. pressure with a superheat of 150 deg. F., but in the design of the new addition it was decided to increase the pressure to 300 lb. with a superheat of 200 deg. F. Therefore the three new boilers which are of the Bigelow-Hornsby water-tube type and rated at 1800

hp. each, were designed for this higher pressure. At present this divides the boiler room into two distinct units; however it is planned eventually to revise the low pressure unit throughout and replace it with boilers to operate at 300 lb. pressure. Figure 2 shows a cross section of the new boiler setting. It is interesting to

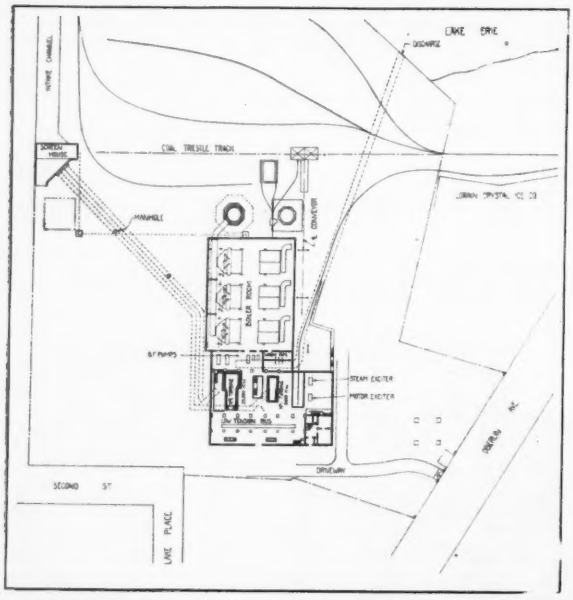


FIG. 1. SUFFICIENT WATER IS ASSURED THE EDGEWATER STATION DUE TO ITS LOCATION ON LAKE ERIE

note that the boiler is of the six-unit type, the last two units acting as economizer sections.

Each of the new high pressure boilers is equipped with a Westinghouse underfeed type of stoker which is 16 retorts wide and which is equipped with a power operated dump and clinker grinder. These boilers are also equipped with Foster superheaters which are designed for 200 deg. F. of superheat at a maximum of 200 per cent boiler rating. The combined boiler and furnace is guaranteed to operate at an efficiency of 78.5 per cent when burning coal of 13,830 B.t.u. The furnace is also guaranteed to burn 18,700 lb. of coal per hr. for periods of less than 24 hr. duration, when using coal of the following analysis: 41.5 per cent fixed carbon, 37.4 per cent volatile matter, 17.8 per cent ash, 3.5 per cent moisture, 4.05 per cent sulphur and 11,512 B.t.u. as fired.

Flue gases are guaranteed to be not over 470 deg. F. when evaporating 45,000 lb. of water per hr. and not over 600 deg. F. when evaporating 135,000 lb. of water per hr. from 200 deg. F. feed water into steam at 275 lb. gage and with a superheat of 200 deg. F. The stokers are driven by 14-hp., 220-v. d.c. motors. The clinker grinder is in two sections and is driven from each side of the boiler setting. There is at present no connection between stoker drives, the motors were not purchased with this in view. Equipment for the emergency drive of stokers consists of one complete unit, including motor and motor control, which are mounted on a lift truck. A spare gear has been provided on each stoker shaft and bolts have been located in the floor for bolting the spare motor in place. Plugs have been placed for cutting in this motor so that there will be a minimum of time required in making this change.

Forced Draft Fans Driven by Induction Motors

Three No. 120, design 4, high-speed turbovane Sturtevant fans of the full housed type are used for supplying forced draft to the stokers. These fans are driven by 150-hp. direct connected motors of the slip ring induction type, 440-v., 3-phase, with remote control push button stations at the instrument board near each boiler. For this service a double set of busses are used with double throw switches, one bus being an emergency feeder. The speed regulation of these motors is made through the medium of motor controlled water rheostats. The fans are guaranteed to deliver 85,000 cu. ft.

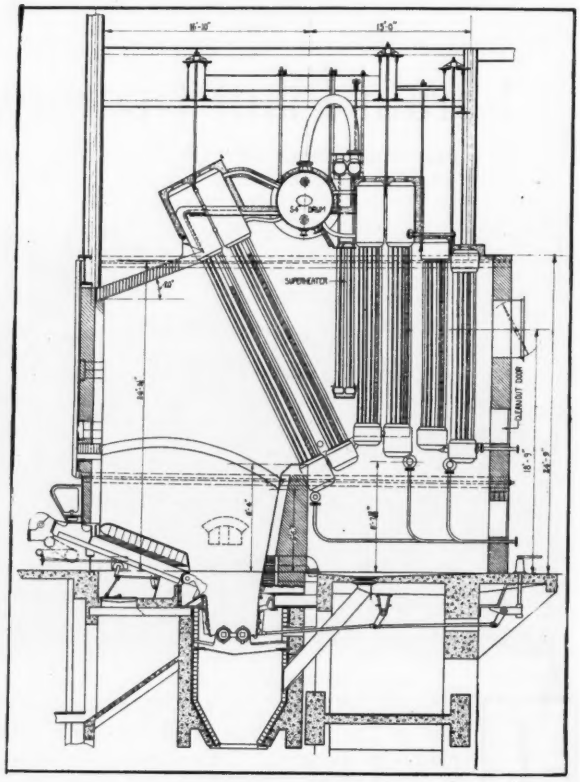


FIG. 2. ECONOMIZER ELEMENTS ARE BUILT INTO THE BOILER SETTING

of air at 6½ in. static pressure at fan outlet, when the temperature of the air is 100 deg. F.

Waste gas is cared for by a 16 by 275 ft. radial brick stack which is connected to the boilers by a steel plate breeching. The maximum size of this breeching is 10 by 22 ft. at the stack. This breeching is suspended from the roof girders by steel rods which are connected to the bottom angles. This was done so that all expansion will be upward and so will not interfere with the boiler flue connections which are made near the bottom of the breeching. Bellows type expansion joints are provided between each setting and the breeching is supported on roller bearings where it enters the stack. No separate economizers have been installed at present, but provision has been made for their future installation in the rear of the boilers.

Ten Diamond soot blowers of the valve in head type have been installed on each boiler. The design of the

superheater was such that it was impossible to utilize a standard design of blower at that point. Therefore a special blower was used which consists of a length of perforated pipe mounted in a trunnion support. This is supplied with steam through a flexible hose in order that it will make an arc through the superheater. This feature is of new design and will be watched very closely for operating data. Dampers are controlled by a Northwestern regulator.

Each boiler has been equipped with an individual instrument board on which is mounted an a.c. ammeter for the fan motor, a d.c. ammeter for the stoker drive, and two d.c. ammeters for the individual clinker grinder drives. There are also mounted on each board a multipointer gage which shows the pressure in the wind box, the fire box, and in the up take; one Bailey meter, type D-26, showing steam flow, air flow and steam temperature; and a recording gage which shows the water and gas temperatures through the economizer. Controls for stoker drive and clinker grinder motors are also located on this panel, as is also a push button control station for operating the fan motor. Provision has been made for a future CO_2 recorder.

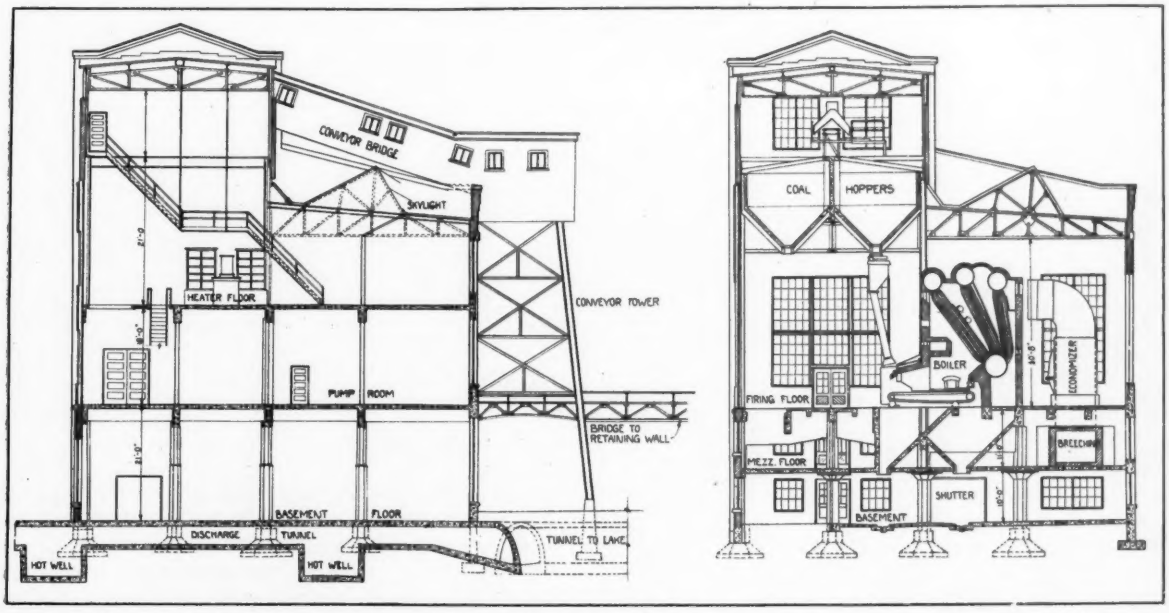


FIG. 3. CROSS-SECTIONAL ELEVATIONS SHOWING THE BUILDING AS PROVIDED FOR THE ORIGINAL INSTALLATION

New Turbine Unit to Be Renozzled for Higher Pressure

In the original generating room layout turbines of not over 12,000 kw. in size were figured on. In going to the larger unit it was found that this room was very small; however, the best possible arrangement was made and the new 20,000-kw. Westinghouse unit is accessible from all points. This unit is rated at 25,000 kv.a., 80 per cent power factor, 6600-v., 3-phase, 60-cycles and 1800 r.p.m. The exciter is direct connected and is rated at 100 kw. and 250 v.

Accessory equipment for the turbine is as follows: One electrically operated speed changer, one steam driven auxiliary oil pump, one steam strainer, one gage board with tachometer, a steam pressure gage, a steam inlet pressure gage, an oil pressure gage, a gland water pressure gage and a vacuum gage. Generator accessories are: One motor operated generator field rheostat, a field discharge resister and a motor operated exciter field rheostat. Although the turbine is guaranteed to operate under 300 lb. steam pressure and 250 deg. F. superheat, those conditions will not be maintained at present. Accordingly provisions have been made so that the turbine can be re-nozzled and re-gaged for the higher pressure. Operating conditions for the present will be 270 lb. steam pressure, 200 deg. F. superheat at throttle and 29 in. of vacuum.

Mounted at the head of this turbine is an instrument board which is equipped with one of each of the following instruments: Indicating volt meter, indicating watt meter, indicating synchronoscope, indicating frequency meter, indicating mercury barometer, indicating mercury vacuum gage, Bailey meter, indicating steam flow, steam temperature and exhaust steam temperature also gage showing condensate and condenser cooling water discharge temperatures. A gage has also been provided which shows the temperature of the air and water in and out of the air washer.

Two Pass Condenser Contains 30,000 sq. ft. of Cooling Surface

Serving the new generating unit is a Wheeler Condenser and Engineering Co.'s surface condenser the shell of which is 126 in. in diameter. This condenser is arranged with two passes for water circulation and contains 30,000 sq. ft. of cooling surface which is composed of 1 in. by 20 ft. seamless drawn brass tubes. These tubes have been packed with one ring of fiber, then a course of corset lacing and this backed up with another ring of fiber. The tubes have also been bowed 1 in. in order to stop rotation caused by the centrifugal force of the water. Water for this unit is taken from a concrete intake tunnel through a Wheeler Condenser & Engineering Co.'s 36 in. D-AA horizontally split casing,

double suction, centrifugal pump. This pump was designed to deliver 40,000 gal of water per min. against a total head of 22 ft. at an efficiency of 80 per cent. This pump is mounted on a cast-iron bed plate with a duplex drive, the General Electric Co.'s motor being rated at 283 b.hp., 3-phase, 60-cycle, 440-v. The steam drive for this unit consists of a 283 b.hp. Terry steam turbine, connected through reducing gears. The reduction in speed is from 2145 to 288 r.p.m. This turbine will be controlled by a thermostat at the feed water heater so that a heat balance may be obtained.

One No. 100 Wheeler Condenser & Engineering Co.'s turbo air pump of the hydraulic type, provided with a base cooler and one Wheeler, size F two-stage steam jet air pump have been provided. Two 5 in. Wheeler, double suction, horizontal split casing, centrifugal hot well pumps have been installed which will handle 575 gal. per min. against a total head including vacuum of 135 ft. One of these pumps is direct connected to a 40-b.hp. General Electric motor and the other pump is connected to a 40-b.hp. Terry steam turbine.

Air Washer Is of Recirculating Type

There has been provided an air washer which is constructed with a specially designed cooling surface and in which the air will be recirculated. Later it is planned to use a non-combustible gas for cooling purposes. Steam jets and dampers have been provided in this washer for fire control.

Lubrication at present is taken care of by a Richardson-Phenix oil filter and a storage tank from which oil is taken by a triplex plunger type Gould pump which has a capacity of 12 gal. per min. against a total head of 66 ft. This system will be used for the new generating unit. Arrangements for filtering oil have been made so that it will be impossible for the operator to drain the oil from the turbine while it is in operation. This has been accomplished by providing an overflow arrangement whereby it is necessary to pump new oil into the turbine in order to create an overflow condition. The oil is taken from the overflow funnel and passed down through the filter and then back into the turbine.

Two 6-in. Worthington, 4-stage centrifugal boiler feed pumps are turbine driven through flexible couplings by 312 b.hp., 2200-r.p.m. Terry steam turbines. These pumps are designed for 1000 gal. per min. against an 863 ft. total head which corresponds to 375 lb. pressure. The efficiency of these pumps is guaranteed to be 70 per cent. Two 8-in. boiler feed lines lead from the pumps to the boilers where each line branches into two 5-in. connections, which are again divided into six 2-in. connections to each boiler. Feed water is controlled with Copes feed water regulators and provision has been made for hand operation when necessary. Connections at the pumps have been made so that one pump and one header can be used for test purposes. These pumps are located directly in front of the 20,000-kw. machine and on the same elevation.

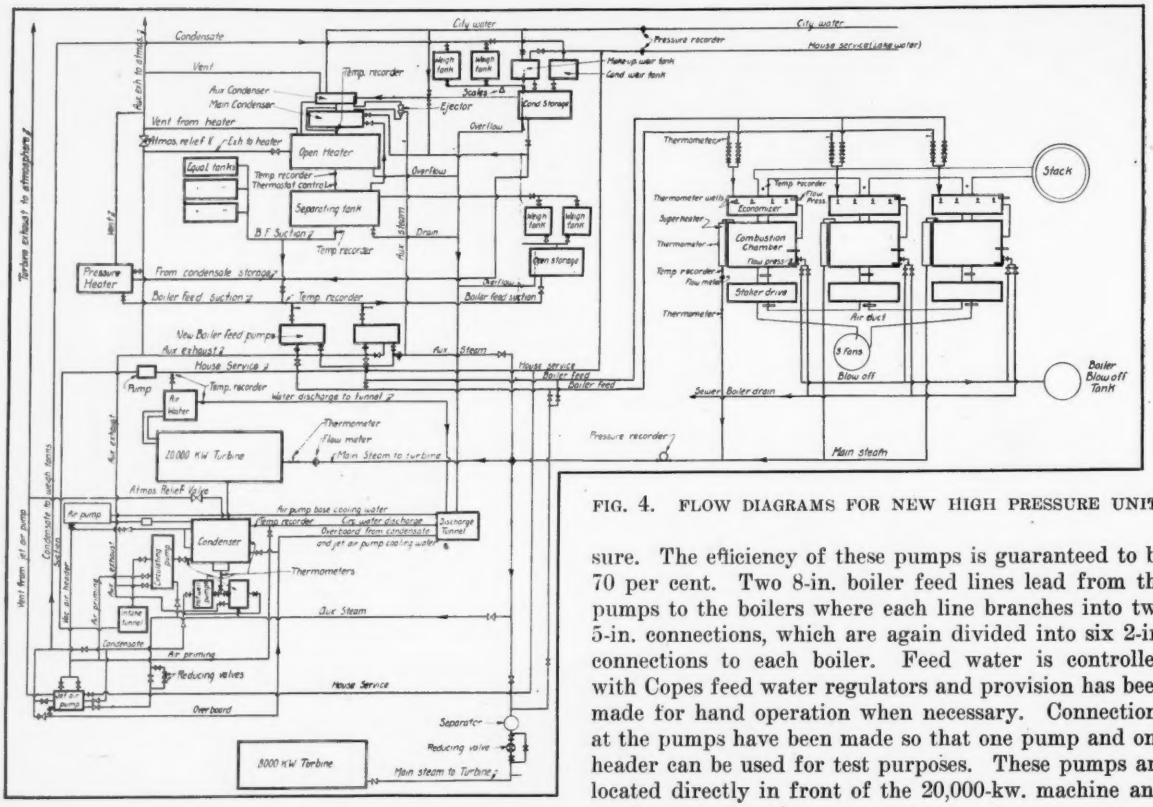
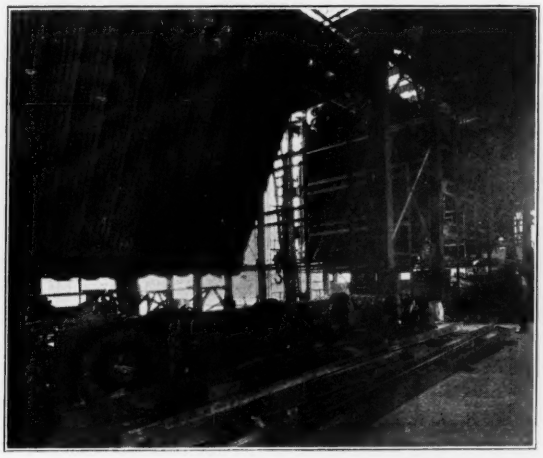
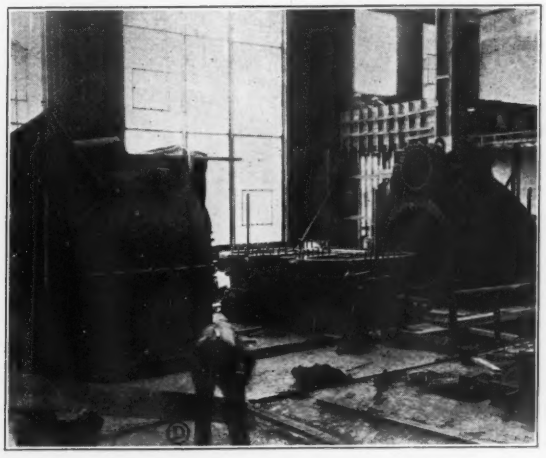


FIG. 4. FLOW DIAGRAMS FOR NEW HIGH PRESSURE UNITS

Immediately above the feed pumps is located an Elliott deaerator, capable of removing air and gases from 400,000 lb. of water per hr. This equipment consists of heater tank, separator tank, condenser tank and air ejectors. The heater is of the horizontal open type and has sufficient capacity to raise the temperature of 400,000 lb. of water per hr. from 60 to 212 deg. F., when supplied with sufficient exhaust steam at atmospheric pressure. The separator is of the horizontal cylindrical type and will have a capacity sufficient to handle and deaerate 400,000 lb. of water per hr. under normal conditions of operation and 500,000 lb. under overload conditions. The condenser is of the conventional surface type and contains 1255 sq. ft. of surface. The feed water not to exceed 100 deg. F. is used for cooling purposes. An auxiliary condenser is provided, of the same general type as the above, with 200 sq. ft. of surface to condense steam from the air ejectors. In this way, practically 100 per cent heat return will be

Fig. 5. Construction Views of Boiler and Turbine Room Equipment

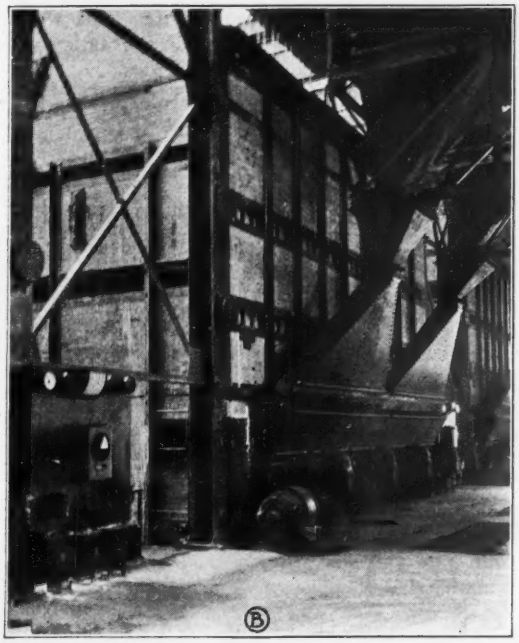




A. This view shows the elements of the Bigelow boilers in place and the stokers partially assembled. Brickwork has been started on the third unit.

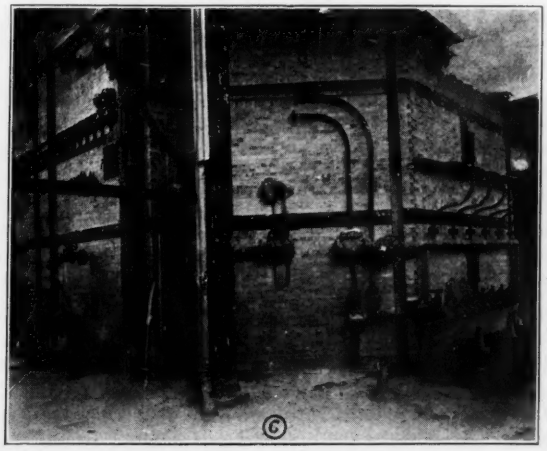
B. Each boiler is equipped with an instrument board on which are also mounted motor controls and an electrically operated valve station. Stokers are driven by individual motors.

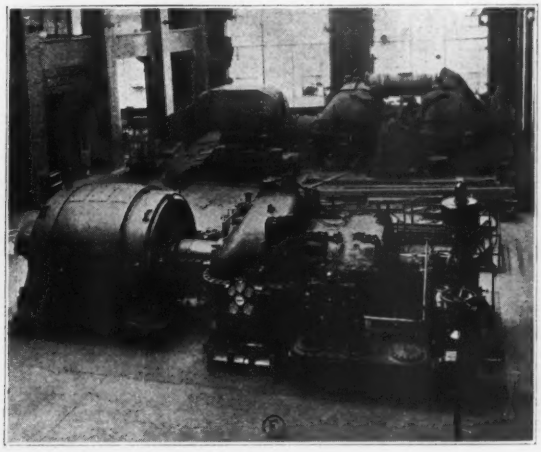
C. Feed water is brought to each boiler through two 5-in. leads from which six 2-in. connections are made to the boiler. Long radius pipe bends and branch laterals are used wherever possible. The main leads from the pumps are 8 in. in dia.



D. This view was taken during the construction of the new 20,000-kw. turbo-generator unit. This turbine will operate at 270 lb. pressure although provision has been made so that it may be renozzled and regauged to operate at a pressure of 300 lb. and a superheat of 250 deg. F.

E. Here are shown the relative proportions of the two generating units. The 8000-kw. turbo-generator is in the foreground. The size of the generator room was proportioned for the small unit. It was found, however, that the 20,000-kw. unit could be installed parallel to the small unit and within the original crane column spacing.





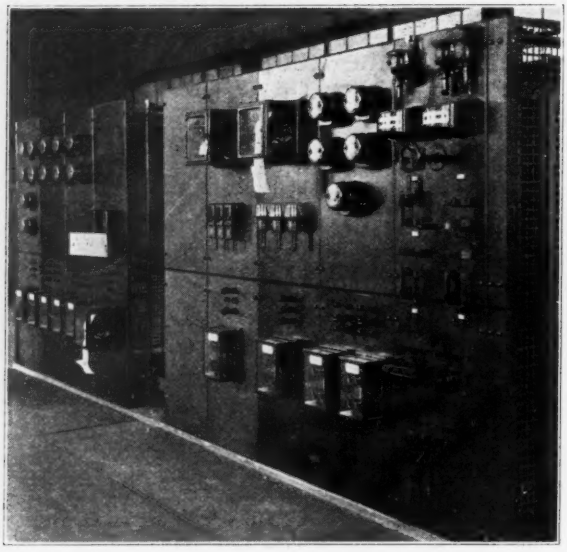


FIG. 6. PANELS ON WHICH ARE GROUPED THE STATION METERS AND RELAYS

available. The necessary gages are provided to watch the operation of this unit.

Above the deaerator equipment are located the condensate weighing and storage tanks. After the water passes through the heater an auxiliary weighing device is provided for use during boiler tests. Both the boiler test and condensate weighing equipment consists of Fairbanks platform scales, supporting steel plate tanks of sufficient capacity to take care of the boiler requirements.

Between the operating floor and basement in the boiler room there has been erected a balcony which carries the 16-in. main steam header and two 8-in. boiler feed headers. These lines are supported on concrete piers and have been installed with a suitable slip joint which allows for expansion. The main leads from the boilers are taken from the center of superheater headers through Schutte & Koerting non-return valves. A 10-in. electrically operated Chapman gate valve is provided at each connection to the main header. These

FIG. 7. GENERAL VIEW OF THE SWITCH GEAR REMOTE CONTROL BENCH

valves will be operated from the boiler instrument boards as will a 16-in. electrically operated valve located in the lead to the turbine. In order to take care of the old equipment from the new boilers, an 8-in. cross connection was made between the old and new steam headers. This 8-in. lead is provided with a pressure reducing valve. Spray nozzles are installed which are supplied with boiler feed water in order to de-superheat the steam to the old unit. It is planned in this way to take care of all steam requirements should part of the old equipment be down.

All flanges on high-pressure piping are of the tongue and groove type, lead antimony gaskets being used on boiler feed lines and aluminum gaskets on steam lines. Nozzles, wherever possible, are of the hammer welded type and lines as low as ½-in. in size are provided with welded flanges to take care of the high pressure which is being used. Special chrome nickel steel bolts were used on all of the high-pressure piping and throughout boiler and superheater equipment.

Installation of the new unit necessitated extending the present concrete bus structure and accordingly five new switch cells were added. A new exciter switchboard was installed which is located near the generator

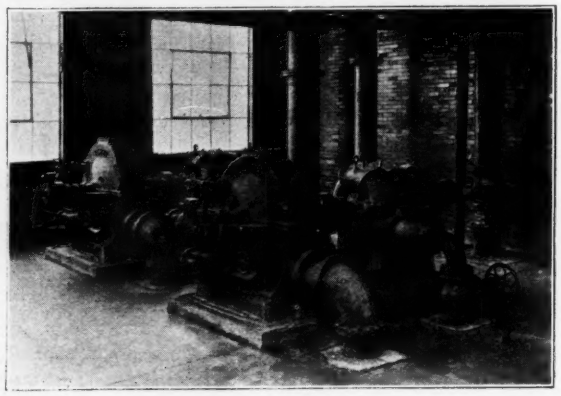


FIG. 8. TWO NEW BOILER FEED PUMPS HAVE BEEN INSTALLED IN THE TURBINE ROOM

end of the new unit. On this board is mounted a generator field and exciter carbon circuit breaker, a motor operated generator and exciter field rheostat, a carbon circuit breaker for paralleling this exciter with the present exciter bus and a carbon circuit breaker for a 250 v. direct current feeder to the stoker and clinker grinder motors. These carbon circuit breakers are all electrically operated from the control room, which is located on the second floor at the end of the turbine room. Windows between the control room and turbine room enable the operator to overlook the entire turbine room.

Outdoor Substation to Be Constructed

Material is on the ground for the construction of a 135-kv. outdoor substation. At present, there will be one 20,000-kv.a. transformer bank installed which will be operated at 69 kv. This substation will connect through the new high tension line the Edgewater plant at Lorain, Ohio, with the company's plant at Mansfield, Ohio. For local distribution a second 22 kv., 15,000-kv.a. transformer bank is being installed in the basement alongside of the present 10,000-kv.a. bank.

All of the alternating current auxiliary motors are of the 3-phase, 440-v., induction type, except the fan motors previously referred to. The former motors are started from a 220-v. circuit and are then connected to a 440-v. feeder for running. Alternating current for these motors is supplied by two 600-kv.a., 6600 to 440-v. transformer banks which are located in the basement. Direct current for operating the stoker and clinker grinder motors can be supplied from either a steam driven or a motor driven exciter both of which are independent of the exciter system through electrically operated interlocked carbon circuit breakers.

pressure of 300 lb. These guarantees are based on an 80 per cent power factor for full rating and the specified loads below rating. At 25 per cent overload the guarantee is based on 100 per cent power factor. The most economical steam consumption will be about 10.5 lb. per kw.-hr. and this will occur at the full rating of the machine.

Stated performance of the condenser is of necessity tied in closely with the turbine. The guarantee is based on a given number of pounds of steam per hour, a stated vacuum referred to a 30-in. barometer and the initial temperature of the circulating water. The guarantee is

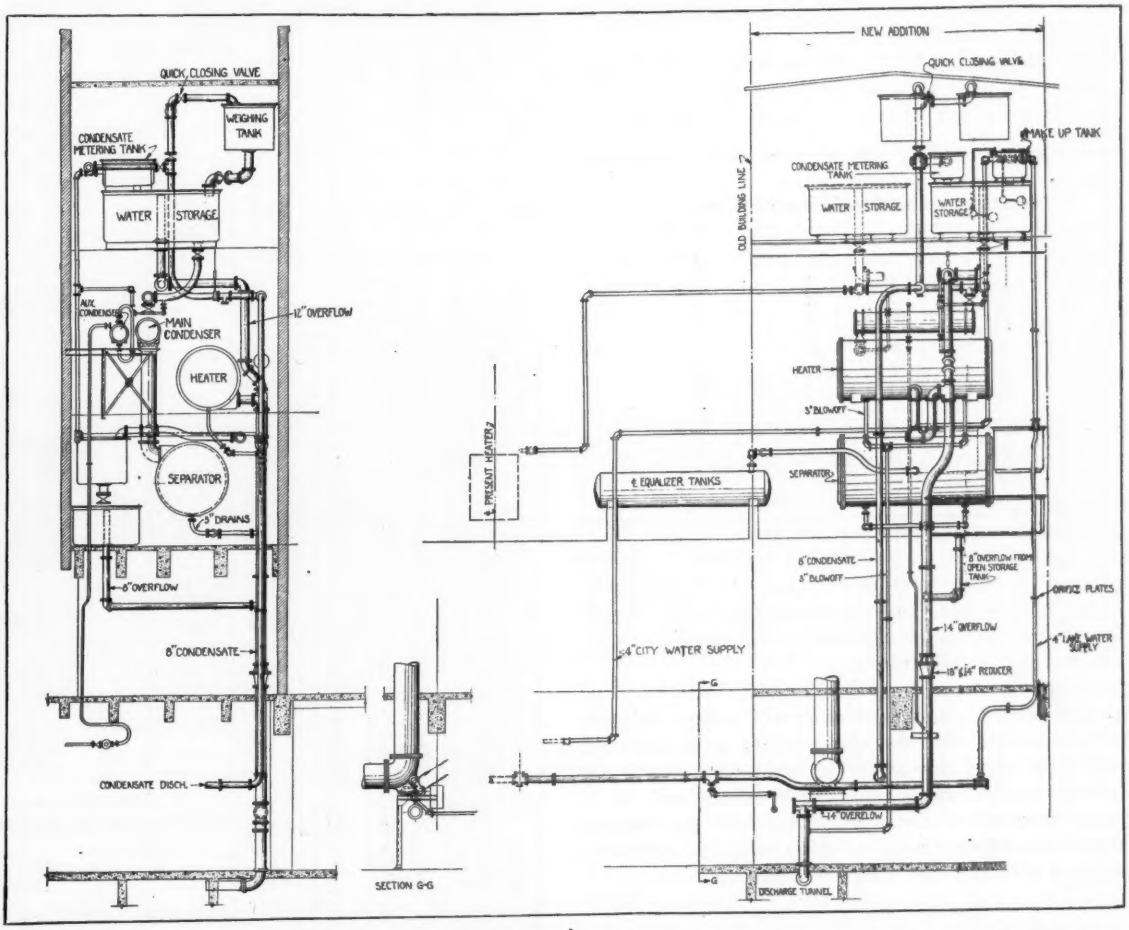


FIG. 9. ELEVATIONS IN WHICH ARE SHOWN THE RELATIVE LOCATION OF WATER STORAGE TANKS AND THE FEED WATER HEATER

Operation of the new unit will be comparatively simple for it is equipped with a direct connected exciter and a Tirrill voltage regulator. The unit can be started and put on the line with a minimum amount of switching. The Tirrill regulator is equipped with an out of phase current transformer, which in connection with the regulator now installed for the present generator, will automatically take care of cross currents between the two machines.

Guarantees on the new generating unit are based on its operation at 270 lb. steam pressure and 200 deg. F. superheat at the throttle and 29-in. vacuum. Since these are the conditions which will be maintained until such time as the plant will be cut over to the single

given then as the number of gallons of water required per minute to maintain the desired vacuum. At rating this unit will require approximately 40,000 g.p.m. of circulating water at 50 deg. F. to maintain a vacuum of 29 in.

This station was designed and constructed by the engineering department of The Henry L. Doherty Co., New York City. T. O. Kennedy, vice-president and general manager at Cleveland, and J. B. Johnson, manager at Lorain, are directly responsible for the operations of this development. The description of this plant was obtained through the co-operation of E. A. Doerr, field engineer in charge of the new construction for the Doherty interests.

Use of Performance Data in Boiler Operation

A Thorough Knowledge of the Internal Characteristics of Each Boiler Will Serve as a Guide for Operating Practice. By Edward K. Tomita

AN ENGINEER in charge of a boiler plant must be an engineer in all that the sense of the word implies. In other words, he must be an engineer not only in a technical sense, that is, in his mastery of the purely mechanical aspect of his job, but he must also be a manager of men. He must be able to direct and co-ordinate the efforts of the men in his charge so as to obtain the greatest benefit for all parties concerned. To do this, he must understand the physical and mental characteristics of the men under him.

In the same way that he analyzes the inner characteristics of his men, so must he also analyze the inner characteristics of his boilers. It is on the importance

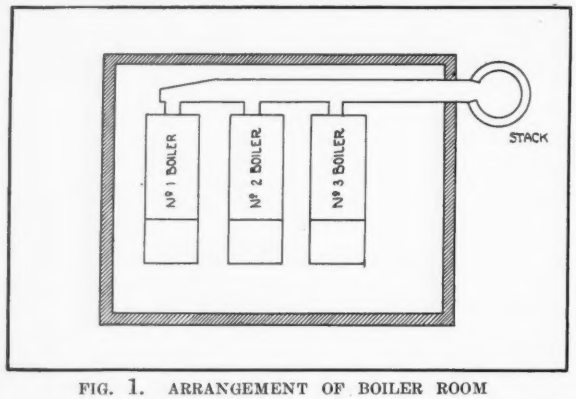


FIG. 1. ARRANGEMENT OF BOILER ROOM

of this latter point, that the writer will endeavor to lay stress, and to point out the manner in which he may apply his knowledge of the internal characteristics of boilers to the best advantage.

Many of us are more or less familiar with the load characteristic studies of generators and motors, because it is the essential feature of operating such machines successfully. The characteristic studies of boilers are no different from those of electric generators. It is the establishment of the relation between the varying load and the apparatus in question with the necessary changes in it to suit best that load condition.

How to Study Boilers

In general the boiler characteristic, or more explicitly the furnace characteristic, is the relation between the rate of fuel consumption and the draft condition to obtain the highest percentage of carbon dioxide without the production of carbon monoxide for a given boiler. Just as in the case with a human being or an electric generator, each individual boiler has its own peculiar characteristics. For instance, considering two boilers of the same manufacture and the same construction, you will find that one has different furnace characteristics from the other; if they have the same characteristics, it is merely a case of coincidence.

In order to simplify the method of obtaining the above-mentioned relationship, we shall take a concrete example and work it from the beginning to the end. Three B. & W. boilers of 500 b.hp. each, are equipped with Detroit V type automatic stokers having a flat suspended ignition arch, working under a natural draft. The flue gas ducts for the boilers are arranged as shown in Fig. 1. The steam demand for this plant varies from 1200 to 2500 b.hp. during 24 hr. or from 80 to 166

No 1 BOILER — DATE June 16, 1922

TIME	FLUE GAS ANALYSIS %CO_2	%O_2	%CO	DRAFT READING WATER OVER FIRE	DAMPER	FLUE GAS TEMP.	%RATED CAPACITY DEVOL.	CONDITION OF FIRE BED	REMARKS
8:00AM	13.1	5.0	.01	.110	.165	390	80	Good	
15	11.8	6.7	.00	.120	.191	395	81	Short flames	damper opening increased
21	12.5	5.9	.00	.118	.187	400	81		" " decreased
30	14.0	4.2	.00	.115	.180	395	81		" " "
37	12.0	6.9	.00	.111	.178	405	84.5		" " dec Ashpit doors
42	12.6	6.0	.01	.100	.177	405	85	Good	1/2 closed
51	13.9	4.6	.00	.100	.175	410	85	"	" " decreased
57	12.8	5.6	.00	.120	.187	410	88		" " Increased
9:02	14.3	4.1	.01	.116	.190	400	68.5	"	" " decreased
08	14.1	4.3	.00	.110	.200	415	70.5	"	
14	11.0	7.5	.00	.125	.225	418	70.5		" " Increased
21	14.3	4.2	.00	.100	.185	418	71.0		" " decreased
30	12.0	6.3	.00	.118	.198	425	73.0		" " Increased
35	12.8	5.7	.00	.110	.185	435	73.5	Fire cleaned	" " decreased
39	13.0	5.5	.01	.105	.185	417	73.5		
47	14.1	4.7	.00	.120	.200	430	75.5		
52	11.8	6.6	.00	.108	.195	440	77		" " Increased
10:00	12.8	5.6	.00	.106	.201	440	78		" " decreased
05	13.8	4.6	.00	.105	.200	432	79	Good	
12	16.2	1.4	1.00	.105	.185	440	100	Coal fed by hand	Too much coal in ash
19	14.0	4.5	.00	.130	.198	439	100	Good	
25	13.4	4.8	.01	.121	.210	440	100.5		
30	10.7	7.7	.00	.116	.195	450	102		damper opening increas.
34	12.8	5.8	.00	.110	.221	445	102.5	Good	
40	13.7	4.9	.01	.110	.205	442	103.5		" " decreased
49	12.9	5.5	.01	.125	.200	445	104		" " Increased
53	13.0	5.5	.00	.110	.215	458	105		" " decreased
58	14.6	3.8	.00	.110	.200	450	106		
11:02	12.6	5.8	.00	.111	.226	450	110		" " Increased
07	13.9	4.6	.00	.130	.230	460	110		
15	13.0	5.4	1.20	.110	.218	462	111.5	Good	
23	13.5	5.0	.01	.120	.223	460	112		
30	11.5	7.0	.00	.130	.231	454	113		
36	12.8	5.8	.00	.145	.240	453	114		
40	14.0	4.6	.00	.127	.218	460	116		" " decreased
49	13.8	5.0	.00	.143	.235	460	115		
54	13.2	5.7	1.30	.143	.235	462	116		
12:00	12.8	6.3	.00	.138	.239	475	117		" " Increased
10	14.0	4.8	.02	.130	.235	465	113.5		" " decreased
15	11.6	7.3	.00	.138	.246	470	118		" " Increased
20	14.2	5.6	.00	.130	.240	468	118		" " decreased
27	12.9	5.4	.00	.130	.241	470	122		" " increased
35	13.0	6.0	.01	.140	.255	475	123.5		
42	12.5	6.0	.01	.110	.237	470	123.5	Holes in fire bed	
50	13.0	5.5	.00	.140	.258	480	124		
1:00PM	14.8	3.6	.00	.133	.254	472	123.5		
04	11.0	7.6	.00	.140	.260	475	124		" " "
09	12.6	5.9	.00	.145	.257	485	123.5		
16	14.1	4.4	.00	.149	.270	480	123.5		" " decreased
23	12.0	6.5	.00	.150	.300	480	130.5		" " Increased
31	12.8	5.7	.00	.145	.285	481	130.5		
39	14.0	4.4	1.30	.149	.270	481	131	Coal fed by fuel	
46	13.9	4.5	.01	.152	.276	478	133.5	Good	
52	12.8	5.9	.05	.138	.300	479	133	Holes in fire bed	" " "
2:00	12.9	5.6	.00	.137	.284	484	133		" " decreased
05	13.6	4.9	.00	.145	.295	480	134	Good	" " increased
10	11.5	6.0	.00	.136	.317	490	134		
2:19	14.0	4.3	.01	.160	.288	484	136		
25	12.0	6.6	.00	.169	.300	490	137		" " "
32	14.1	4.4	1.60	.150	.326	490	138		" " decreased
40	12.9	5.7	.00	.168	.320	490	138		" " Increased
45	13.5	4.9	.00	.165	.309	495	138.5		" " decreased
52	12.8	5.7	.00	.160	.318	490	138		
3:00	14.8	4.5	.00	.155	.320	495	138.5		
9	12.0	6.6	.00	.165	.345	495	140		Increased
15	14.1	4.4	1.00	.140	.321	500	140		decreased
19	13.8	4.7	.00	.118	.330	490	142		increased
25	10.5	7.9	.00	.111	.330	520	141		
30	12.0	6.4	.00	.118	.320	490	141		decreased
34	14.3	0.8	.50	.151	.330	497	141.5		"
40	13.1	5.3	.01	.185	.345	491	144		
45	12.8	5.1	.01	.163	.340	495	144.5		Ashpit door wide open
51	13.0	5.4	.00	.170	.352	495	144		
4:00	11.5	7.0	.00	.140	.378	515	145	Holes in fire bed	damper opening increased
5	12.8	5.1	.00	.118	.371	510	141.5		decreased
10	14.4	3.8	.00	.135	.353	500	140		
14	14.0	4.6	.00	.146	.371	530	150		Increased
20	13.9	4.6	.00	.240	.340	505	152		decreased
26	9.1	8.8	.00	.240	.430	540	153		Increased
32	12.6	6.0	.00	.250	.415	530	154		decreased
40	13.5	4.9	.01	.230	.382	528	156		"
45	13.5	4.9	.00	.230	.400	530	150		
50	10.6	6.8	.10	.187	.500	530	152	Big hole in fire bed	Increased
55	12.6	6.0	.00	.231	.430	530	151.5		decreased
2:00	14.2	4.4	.02	.245	.415	537	154	Good	
7	11.0	7.6	.00	.250	.460	535	160		Increased
12	14.0	4.5	.01	.235	.435	530	161		decreased
19	11.0	7.6	.00	.241	.450	540	161		Increased
25	12.0	6.5	.00	.236	.435	537	162		
31	12.7	5.7	.00	.235	.440	530	163.5		
40	13.5	4.9	.00	.235	.434	530	162		decreased
45	11.0	7.6	.00	.240	.470	560	163		increased
50	12.2	5.3	.00	.255	.452	595	164		decreased

FIG. 2. OPERATING DATA ON NO. 1 BOILER

per cent of the rated capacity. First we must make provisions for taking draft reading over the fire and at the last pass just before the damper. A flue gas sampling pipe is placed in the last pass and if a suitable recording or indicating thermometer is available, place it in the last pass to get the flue gas temperature. Before proceeding further, see that the settings are tight and the boiler heating surfaces are at least fairly clean. If the load condition permits, operate the three boilers at or about 80 per cent of the rated capacity. This can be determined approximately by the rate of coal consump-

tion or if each boiler is equipped with a boiler meter or steam flow meter, we can tell exactly what rating the boilers are developing by looking at the charts. If the load condition does not permit to operate all of them at 80 per cent capacity, operate the No. 1 boiler at that capacity and let the other two boilers take care of the remaining load.

Now we are ready to take the necessary data for the No. 1 boiler. Analyze the flue gas as to per cent carbon dioxide, oxygen, and carbon monoxide and at the same time take the draft gage readings over the fire and at the last pass. Also observe the condition of the fire as to holes in the fire, clinkers, etc., and if a thermometer is placed in the gas passage at the last pass take the flue gas temperature reading. Repeat this cycle as many times as required until a given set of conditions is found which produces the highest percentage of carbon dioxide gas without carbon monoxide, keeping in mind that the best combustion condition, all the other things being equal, exists when the draft over the fire is the least. This is accomplished by changing the amount of the boiler damper opening. Prepare a table as shown, Fig. 2. Increase the load by any desired intervals and

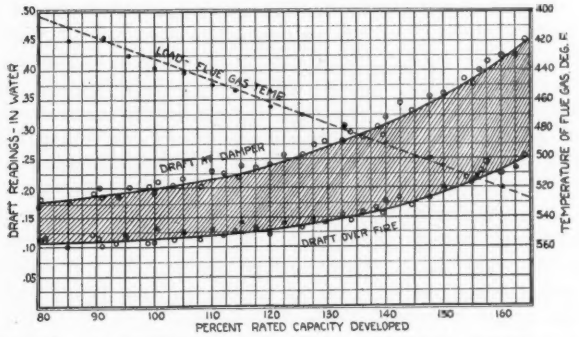


FIG. 3. A TYPICAL BOILER CHARACTERISTIC CURVE. A STUDY OF NO. 1 BOILER

find the best draft condition for each of the loads. Each time when the flue gas determinations are made, the other readings taken and the condition of the fire bed noted, record them in the table. In like manner, data for No. 2 and No. 3 boilers can be obtained.

How to Construct the Chart

Having obtained this data, the next step is to put them in a graphical form as shown in Fig. 3. These curves are plotted by selecting the best combustion condition for each of the loads from the table, Fig. 2. For example, for the load at 80 per cent, 14 per cent carbon dioxide is obtained without carbon monoxide; the corresponding draft over the fire is 0.115 and that at the damper is 0.180 in. of water. These points are plotted and smooth curves are drawn through them. The shaded portion represents the loss of draft through the boiler setting.

To use these curves to best advantage a set of them should be placed on the boiler floor at some conspicuous and readily accessible location, so that the operators may be able to check the draft condition of each boiler from time to time. It is advisable to place each chart in a picture frame with glass to keep out the dirt. The engineer in charge of the plant should also have one set so that he can check up the draft condition of each boiler by comparing it with the record on the daily log sheets or draft recording chart and the steam output charts, if these are available. In this manner, any erroneous combustion condition may be readily corrected by the watch engineer or the repetition of the similar errors may be checked up and corrections made thereof by the engineer in charge.

These curves also serve to indicate the condition of baffles and also the infiltration of air through the boiler setting. A broken down or a leaky baffle will result in a smaller loss of draft through the setting with a higher flue gas temperature for a given load. For example, if the first pass baffle is badly broken down, the load carried is 120 per cent of the rating, the draft drop may be 0.18 in. of water instead of 0.225 in. and the flue gas temperature may rise to 550 deg. instead of 465 deg. as shown by the chart. A leaky setting is indicated by a large draft at the damper and a small draft over the fire. The temperature of flue gas may increase or decrease depending upon the amount and the location of the infiltration.

In order to have the relation of the load and the flue gas temperature more handy, it is advisable to plot it on the same chart as shown by the dotted curve. The usefulness of this is already explained above.

First Principles of Refrigeration

Mechanical refrigeration is produced by expanding a heat medium from a normal temperature to one which is below the usual limits for the climate and zone where the expansion takes place. Media are chosen with regard to their willingness to surrender their heat energy to surrounding objects, and vapors are therefore best employed. The vapor chosen is compressed and then relieved of its heat in order to diminish its volume. It is then expanded so as to do mechanical work and its temperature is lowered. The absorption of heat at this stage by the vapor in resuming its original condition constitutes the refrigerating effect. Ammonia, sulphur dioxide, pictet fluid, carbon dioxide and air are the gases most used for this purpose.

In the ammonia compression system, which is the one most generally employed, the ammonia vapor is compressed to about 150 lb. pressure and a temperature of 80 deg. F., and is then allowed to flow into a cooler or surface condenser, where the heat due to the work of compression is withdrawn by the circulating water and the vapor is condensed to a liquid. It is then allowed to pass through an expansion cock and to expand in the piping, thereby withdrawing heat from the surroundings. The expanded ammonia gas is then drawn into the compressor under a suction of from 5 to 20 lb., thus completing the cycle of operations.

Brine used in indirect systems of refrigeration consists of a solution of salt in water. Liverpool salt solution weighing 73 lb. per cu. ft. of specific gravity 1.17 will not congeal at zero degrees F. American salt solutions or brines of the same proportions congeal at 20 deg. F. The quantity of ammonia liquid required is about 0.3 lb. per ft. of piping. Leakage and waste amount to about 2 lb. per year per daily ice capacity of one T. The temperature of the brine should be maintained at a point about 5 to 15 deg. F. below the temperature of the space it cools.

Standardization of Engine Stops*

REQUIREMENTS FOR ENGINE STOPS TOGETHER WITH PROPOSED SPECIFICATIONS DRAWN UP BY THE A. I. & S. E. E. BY WALTER GREENWOOD†

TO SAFEGUARD the automatic operation of modern power plant apparatus there have been devised various types of control equipment. In spite of the fact that such control equipment has been recommended as being perfectly reliable, there are many persons who are so skeptical concerning them that they place the greatest reliance upon the attendants who are supposed to be careful.

The frequent failure of all kinds of automatic limit devices, such as engine stops, hoist and travel limits that were considered perfectly reliable, furnishes excuse for skepticism in those who have not given much attention to their construction and installation. To those who have given much thought to the subject it is plain that correct construction, installation and methods of operation would, if practiced, prevent failures. If this is true, standards that tests and experience have shown to be reliable, should be provided, and it should be the duty of associations formed for the advancement of ideas that interest industries, to agree upon such standards and bring them to the attention of those interested.

In this article arguments will be presented which, it is hoped, will be convincing, in favor of standardization, in this discussion of automatic engine stops.

None but those who are constantly employed in the work of analyzing the conditions that surround accidents, can fully realize the importance of standardization in the features belonging to equipment in order to avoid accidents. In studying the requirements for general specifications for construction, installation and safe methods for operating engine stops, such construction and methods only have been considered as obviously are important, and the lack of some one of which was responsible for every flywheel and almost every turbine explosion that ever occurred.

Speed regulators (governors) almost justify our confidence in them, as also do good attendants; but history tells us they often fail. Generally their failure is occasioned by contributary causes other than imperfect construction or lack of good attention. The office of a speed regulator is to control speed to suit load conditions and, of course, to prevent over-speeding. The office of an automatic engine stop is to guard the speed regulator and act when it fails, or when the attendant does not or cannot act promptly.

ACCIDENTS ARE OFTEN CAUSED BY NEGLIGENCE

In looking over the literature on automatic engine stops, furnished by manufacturers, we find that every contingency that might arise and cause an engine or turbine to over-speed has been considered, and advice has been given by them concerning the making of all kinds of installations. In looking over the installations that have been made, we find too many cases where important advice and necessary requirements have been neglected.

An examination of the records of flywheel and turbine explosions will readily indicate the reason why the suggestions herein contained should be complied with. We recall a case where an engine driving a generator would over-speed and trip the automatic stop valve. The interruption it caused was serious. The department head in charge of the engine insisted the control governor was all right and the trouble was in the stop. The department head responsible for the condition of the equipment for tripping the automatic stop valve insisted it was all right. The general superintendent became interested in the matter and ruled that the automatic tripping device should be made inoperative. The result was that within 24 hr. there was a bursted flywheel. In another case, an engine that drove a large continuous mill raced a number of times, tripping the automatic stop each time, sometimes when there was a piece in the passes. The delays were serious and annoying, so it was decided by someone connected with the rolling to block the engine stop. The result was, an 85-T. flywheel burst within a short time afterward.

Another instance illustrates the importance of requiring stops to reveal impairment to installation by coming into action. An engineer in charge volunteered to demonstrate the reliability of his equipment, which was an open circuit installation with current furnished by a dry battery. When a station switch was closed the stop failed to respond, and investigation revealed that the battery was dead.

In one prominent power plant, the turbines are equipped with motor operated valves that will shut off steam when dangerous overspeed occurs. On one occasion, the control valve on one of the turbines failed and the motor operated valve automatically shut off the steam; but owing to the failure to provide against motoring by proper wiring, the turbine gained sufficient speed to do considerable damage before it could be stopped.

In the same power house they were trying out an installation of a 15,000-kw. turbo driven generator before completing the wiring to the motor operated valve. After starting the turbine the control valve failed, and it was only by quick action and taking much risk that the damage was limited to breaking of some foundation bolts.

Two accidents are called to mind where changes were being made in two turbine installations, each of which was supplied with an automatic stop, and in both cases they were trying out the installations with the automatic stops blocked or made inoperative. Four persons lost their lives in one of these accidents and two in the other by bursting of the turbines.

If we were to continue relating experiences with which we are familiar, we should prove most conclusively that where a flywheel burst, and in many cases where a turbine burst, the engine or turbine being equipped with an automatic stop, there was something lacking in the installation or there was some fault in caring for it that was responsible.

In codifying the general safety principles to govern the make and installation of automatic engine stops, consideration should be given to the wide variation in style, construction and purpose of machines to which they are to be applied. It seems as if any of the principal makers of engine stops can furnish a design suitable for

*A paper delivered at the 17th Annual Convention of the Association of Iron and Steel Electrical Engineers.

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any requirement if it is rightly installed and maintained, and too, it seems as if it would be hard for anyone who has had an all round experience with all makes of stops, produced by different manufacturers, to decide on a preference to the exclusion of all others.

Factors Which Contribute Towards the Reliability of Engine Stops

Experience has proven that the following hints are worthy of consideration:

Preference should be given to the closed circuit system. The most serious objection raised against it is that possibly it is more liable to be brought into operation unintentionally and cause inconvenience than the open circuit system is. As far as current failure is concerned, this can be guarded against; as far as failure of wiring is concerned, it seems best to have it revealed by action of the stop, regardless of the inconvenience that may be caused.

An open circuit system may be defective or out of order for a considerable period of time before its condition is discovered. Inspection and testing may be much neglected; the battery may have become exhausted or the circuit may be broken. These objections to both systems, however, can be minimized to a large extent by proper installation of equipment.

Makers of valves have taken into consideration the importance of being able to reset a valve before an engine stops if necessary. Automatic valves should be so constructed that, through design or carelessness, they cannot be made inoperative and left in that condition while the engine is running, or in other words, so that the engine cannot be started or run unless the automatic stop valve equipment is in condition to perform its office.

Stops Should Be Tested Frequently

Engine stops should be tested frequently to prove that they are in good order. Such tests usually are made by using them when it is necessary to stop the engine, or they are made without stopping it and the reset is made while the engine is running. In addition to such tests, occasionally tests should be made by actually overspeeding. By whatever means overspeed is obtained, provision of some kind should be made for positively preventing the adjustment of the control governor, through ignorance or carelessness of an attendant, so that it will permit overspeed in excess of that which should be required for bringing the automatic stop into action, which speed should not exceed the normal required speed by more than 10 per cent.

Improper kind of packing around valve stems; improper balance of balanced valves; improper method of lubrication of parts of valves, are matters that can cause failure. These, along with other defects in installation and make, could be avoided if proper specifications were strictly followed in all cases, or if daily or even weekly attention were given.

Applying automatic stops to steam turbines seems to be important. Quoting a prominent author of a book on steam turbines, "The mechanical valve-gear does not often get out of order, but sometimes the unexpected happens. The shop man may not have properly set up the nuts on the valve stems; may have fitted the distance bushings between the shield plates too closely; the superheat of the steam may distort the steam chest slightly and produce friction that will interfere with the regulation. If any of the valve-stems should become loose in the crossheads, they may screw themselves either in or out. If screwed out too far the valve-stem becomes too long and the pawl in descending will, after the valve is seated, continue downward until it has broken something."

Causes of Flywheel Explosions

All persons who are responsible for making installations of engine stops, and all persons charged with the responsibility of operating them, should be acquainted with the following list of causes for explosions, possible combination, and improper methods:

Flywheel accidents are caused by overload or overspeed. Overload suddenly released will cause a flywheel to race. Overload may be produced by:

1. Clogging of the machinery in the mill or factory.
2. Unusual imposition of separate loads at the same time.
3. Careless or ignorant handling of friction clutches.
4. If the engine drives electrical machinery, an overload may be produced by a short circuit, the sudden releasing of which causes the damage.
5. Sudden stopping of the engine, due to obstruction or defects.

Overspeed causes the flywheel to explode by centrifugal force. By "overspeed" is meant the accidental increase in speed over that at which the flywheel will safely revolve, commonly called racing. Racing may be produced by:

1. Governor being improperly designed.
2. Slipping or breaking of governor belt.
3. Breaking of governor pulley.
4. Derangement of governor by internal or external causes, as when it sticks or a rod breaks.
5. Derangement in valve gear.
6. Sudden reduction of load as when the main drive belt or clutch breaks or an armature burns out, etc.

Besides these principal causes there are contributing causes such as:

1. Failure of some part of an engine, as when its bed breaks or its shaft fails.
2. An idle pulley or driving pulley may break and hurl its fragments into the governor or valve gear.
3. Defects in design or material of the flywheel.

When a condensing engine overspeeds, even after the steam has been shut off, unless the vacuum is broken, racing may continue until the flywheel explodes.

When an engine starts to race, machines that it drives are shut down by the operators. The decrease in load causes a further increase in speed, which causes the flywheel to burst by centrifugal force.

For automatic engine stops, the following combinations are possible:

1. Independent governor may be either:
   a. Electrically actuated.
   b. Steam actuated; or
   c. Mechanically actuated.
2. Combined trip and throttle valve.
   a. With magnet for closed circuit electrical operation.
   b. With solenoid for open circuit electrical operation.
   c. For closed circuit storage battery.
   d. For open circuit dry battery.

e. To be steam actuated.

f. Steam actuated and also fitted for open circuit electric operation.

g. Steam actuated and also fitted with storage battery for open circuit electric operation.

h. For mechanical operation.

3. Butterfly valve.

a. With magnet for closed circuit electrical operation.

b. With solenoid for open circuit electrical operation.

c. With magnet for closed circuit storage battery.

d. With magnet for open circuit dry battery.

The following methods and combinations for stopping an engine, should not be classified with automatic stops for quick closing.

1. A throttle valve attached through gearing to a motor or any mechanical appliance, for closing the throttle.

2. A mechanical device that is auxiliary to and connected to the control governor.

Rules for Operating Engine Stops

1. All parts of an automatic engine stop equipment must be closely watched by attendants, and kept in perfect condition all the time.

2. Engines that are supplied with automatic stops must be shut down by using the stops at least once each day, which means once each turn, if the engine is operated intermittently.

3. Engines that are run continuously for a long period of time must always be shut down when a stop is made, by bringing the quick closing valve into operation.

4. In addition to using the automatic stop when shutting down an engine, the apparatus must be tested once each day or turn to see if it is in perfect working condition.

5. Periodically, as conditions or convenience will permit, each engine stop must be tested by overspeeding the engine.

6. When an automatic stop operates unexpectedly and apparently the apparatus is in perfect condition, trouble should first be looked for in the control governor, and a test should be made by overspeeding the engine.

7. When a control governor is found to be out of order, immediate steps must be taken to put it in good order.

8. Where a trip is brought into action by a pin, projected by centrifugal force, the pin should be inspected, cleaned and oiled periodically as conditions will permit.

9. All parts of the valve and tripping devices, subject to wear and interference by foreign matter sticking to parts, must be kept constantly clean and lubricated. Cylinder lubricant must be admitted ahead of the automatic closing valve.

10. In the case of lubricating valves on steam turbines, if there may be any objection to admitting lubricant on buckets it must be admitted directly on the valve parts, in quantity just sufficient to effect perfect and continuous lubrication.

Specifications for Construction and Installation of Automatic Engine Stops

For the purpose of securing maximum safety and efficiency, the Safety Committee of the Association of Iron and Steel Electrical Engineers has drawn up the following general specifications covering the construction and installation of automatic engine stops.

It is intended they will apply to all automatic engine stops of whatever kind or method, insofar as they or any part of them may be applicable.

Automatic Quick Closing Valves

For steam pressure above 150 lb. extra heavy valves should be used. Preferably they should be of steel on account of shock, high pressure and high temperature.

A combination stop and throttle should not be employed where the steam line is over 3½ in. in diameter.

For condensing steam engines and for turbines, vacuum breakers should be used and operated in conjunction with the stop valve.

Valves should be of full working capacity to insure minimum pressure loss, at the same time should not be so large that leakage past clearances will operate engine without load at full speed.

Drawings showing full directions for installing and wiring should be furnished by the manufacturer.

As far as possible, the use of fibrous packing, or packing composed wholly or in part of organic matter, should be avoided. Metallic packing should be used wherever practicable.

Stems that must be packed to prevent leakage of steam, preferably should extend in or above a horizontal line.

Where an automatic valve is constructed with a bypass for equalizing pressure on both sides in order to reset it, the valve in the bypass should be of such make that it cannot remain in the position that would prevent the main valve from operating after the attendant had released his hold on the bypass valve.

Electrical Equipment

Current. Where high tension direct current 110 to 220 v. is available, current should be supplied by generators in addition to current furnished by storage batteries. The batteries should be of sufficient capacity to deliver necessary current during the interruption of main source of supply for any period that is likely to occur. The number of cells should be so proportioned to the resistance that they will float on the line when fully charged. Battery should be placed in a clean cool place easy of access. Preferably one battery of sufficient capacity for all engine stops in a plant should be provided.

Switches. Switches and contacts for opening the circuit should break on both sides of the line, in order to prevent the current from being maintained through a ground on one line. Where engines or turbines are connected to generators, a holding or knock-out coil on the circuit breaker should be placed in series with the stop circuit, or a separate circuit should be provided to trip the breaker when the automatic stop operates.

Stop stations. Switches at stop stations must be of the type for manual operation. They should be enclosed in dust proof cases having glass in the covers that can be broken to operate the switch. The cover should be supplied with a lock so that the case cannot be opened unless for the purpose of renewing glass, or for making tests without breaking the glass.

Switchboards. The panels should be slate and not less than 1 in. thick, or of other insulating material. Mounted on the switchboard, for closed circuit system,

should be a voltmeter, ammeter, charging instrument, adjustable resistance and dial switch so arranged that the charging rate of battery may be varied at will; a main switch and as many circuit switches as may be required; an automatic reverse current circuit breaker so arranged that, in event the voltage drops or fails entirely, it will automatically disconnect the battery from the generator and will, as soon as the voltage is restored, again connect the battery and generator.

Wiring. The wiring should be double throughout, extending to the tripping apparatus and vacuum breaker, if there is one. In case wires are extended for more closers, the wires should be opened, extended to the new closers and back in the line again that all circuit breakers or closers may be included. Wires should never be shunted to other wires.

Test board. For an open circuit system a test board should be supplied, containing the necessary equipment for making tests. The wires should be so arranged that tests can be made to prove that all are intact including wiring to the coil itself without tripping the stop. The switch for this purpose must be held normally in position by spring tension, so that it is impossible to leave it in the testing position.

Tripping Devices

Governors. Where a fly-ball governor with belt drive is used for the initial requirement in bringing an automatic stop into operation, it may be of the horizontal or of the vertical type, that is, the spindle may be horizontal or vertical.

Belting. The governor should be driven by multiple rope drive to insure positive operation even though all but one of the ropes should fail. Each rope should be amply strong to perform the work required by all.

Pulleys. The pulleys should be grooved and should be proportioned for normal speed. If a flat belt is used, the pulleys should be flanged on both sides. Where more than one flat belt is used, they should travel on separate pulleys.

Adjustment. The governor should be so adjusted it will by performing some office, like breaking or closing a circuit, tripping a latch, etc., bring some auxiliary part into operation, which in turn will cause the automatic valve to close when the engine reaches the maximum limit of speed required for tripping, which should be approximately 10 per cent in excess of normal.

Horizontal governors. A governor of the horizontal type should have an idle arm and pulley attachment, with the pulley riding on the belt so that should all the belts break or come off, the arm will swing down and open or close the circuit, as the case may require, through the medium of suitable attachments.

Vertical governors. A governor of the vertical type should be provided with an idle arm and pulley attachment with the pulley riding on the belt as described for horizontal governors, or it may be so constructed the belt will, by its tension, hold the pulley shaft of the driven pulley on a line that is at right angles with the line of travel of the belt, and so that if the belt breaks or comes off the vertical spindle will revolve sufficiently to make or break the electric circuit, through the medium of suitable attachments, as may be required by the system employed.

Motion rectifiers. If a governor is used for bringing the stop into action on a reversing engine, a motion rectifier should be provided for converting alternating rotary motion, as produced by reversing blooming engines, into motion of one direction, to prevent its going into action due to sudden reversal at or below normal speed.

Steam operated governors. The same general arrangement prescribed for breaking electric circuits or tripping mechanical devices should be followed, as far as belt drive is concerned, in the installation of steam operated governors. Valve stations for bringing the emergency valve into operation should be located not more than 30 ft. distant from the stop valve.

Pins projected by centrifugal force. Where a pin that is projected by centrifugal force for operating a tripping device is pocketed in the rim of a flywheel, a crankpin disk or a counterbalancing sector, or a yoke on an engine shaft—the yoke being specially provided for holding a pin—the pin and pocket should be machined for an easy fit, but not too loose. If a compression spring is used the spring should be of such diameter it will not bind in the pocket when reduced in length by its utmost compression, and the coils should be so open that the utmost compression required will not bring them in contact with each other.

Reserve Stocks of Bituminous Coal Increase

Consumers of soft coal continued to add to their storage piles during August and on Sept. 1, 1923, they had on hand approximately 56,000,000 net T. The passing of August, 1923, brought to a close a year of practically uninterrupted accumulation of stocks, and the stock-taking as of Sept. 1 revealed many interesting and important facts: Stocks on that date were 4,000,000 T. larger than on Aug. 1, 1923; 7,500,000 T. larger than on Nov. 1, 1921, and nearly 300 per cent larger than on Sept. 1, 1922; the course of stocks has been constantly upward during the past 12 mo., except during February; during the 7 yr. for which records of stocks exist, the riods at the close of the war and just prior to the miners' strike of 1922.

Measured in terms of tons, stocks increased 7.7 per cent in August. Measured in terms of days' supply, the increase was 4.5 per cent. The smaller increase in days' supply is accounted for by the fact that the rate of coal consumption increased in August, thereby shortening the time that the available tonnage would last. At the rate of consumption during August the stocks on Sept. 1 were sufficient to last 46 days on the average, against a 44 days' supply on Aug. 1, at the rate of consumption in July. These averages are based on the assumption that the supply was evenly distributed. As this is never the case, the use of such averages is permissible only for general comparisons, and it should be borne in mind that stocks much above and below the average have entered into the computation. The reports showed that some consumers and localities had extremely heavy stocks, while others had practically no reserves.

In addition to the quantity estimated as being in the storage piles of actual consumers, the following quantities are known to have been in transit on Sept. 1: On the docks of Lakes Superior and Michigan, 6,400,000 T.; in storage at the mines, 440,000 T.; in cars awaiting dumping at lower Lake Erie ports, 625,000 T.

Mechanical Atomization of Fuel Oil---I

MANY DEVELOPMENTS HAVE BEEN MADE IN THE COMBUSTION OF FUEL OIL AND PARTICULARLY IN THE DESIGN OF MECHANICAL ATOMIZERS. BY CLAUDE C. BROWN

AT THE present time, the best known method of burning fuel oil in furnaces and under steam boilers is by its introduction into the furnace in the form of a finely divided spray, or what is called an atomized condition. This finely divided or atomized spray, shot into the furnace, immediately takes fire and forms the oil torch or flame. The efficiency of operation and the completeness of combustion of this fuel oil depends to a large extent upon the degree or completeness of this atomizing operation. In other words, the more perfect this atomization, the more completely the oil is broken up into minute particles and the more perfect will be the resulting combustion and the greater the portion of the fuel oil that will be completely consumed. The efficiency of combustion is also dependent to even a greater degree upon the manner of admitting the air for combustion

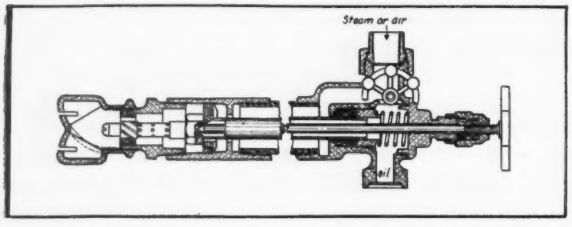


FIG. 1. INTERNAL MIXING TYPE OF OIL BURNER

and the proportionate amount of air admitted. Another highly important factor in the successful operation of an oil burning furnace is the form, type, and volume of the furnace employed.

Atomization of fuel oil has been accomplished in several ways. Among the earlier methods which produced fairly satisfactory results and which have been used a great deal in all oil burning work were the methods of atomizing the fuel oil by steam and by compressed air.

Atomization by means of steam or compressed air is accomplished by intimately mixing the oil spray with the steam or air jet either within the burner itself or immediately after the oil had left the burner tip. The first method, which is called "Internal Mixing," utilizes a burner such as shown in Fig. 1, wherein the fuel oil is sprayed into the steam or compressed air chamber of the burner through a series of small apertures and the whole mixture shot out through a nozzle or slit in the burner tip.

The other method of mixing is called the "External Mixing" method and utilizes a burner wherein the steam and oil or the air and oil are kept entirely separated within the burner itself. The nozzle or tip of the burner contains two slots, the top slot being the oil outlet and the lower slot being the atomizing steam or air outlet. Such a burner is shown in Fig. 3.

In this method, the steam or air produces a flat fan shaped jet on the top of which is spread the fan shaped jet of fuel oil. The two being thus closely associated and issuing from the burner tip with considerable velocity, become more or less intimately mixed and form an oil vapor which readily ignites in the furnace. Considerable experience and experimentation has shown that for the combustion of fuel oil in large installations, the method of atomizing the fuel oil by means of the steam jet rather than the air jet has given the most efficient, reliable and satisfactory results.

There are, however, many objections to this method of atomization. In the first place, the amount of steam used will vary from 1.3 to 4 per cent of the total steam generated by the boiler, depending upon the type of burner used, the character of operation, the care and efficiency that is employed in the control of the steam used for atomization and the temperature of the fuel oil that is being atomized. Where extreme care is exercised in the regulation of the amount of steam thus used, cases have been known where the quantity of steam used for atomizing purposes has been kept down to 1.3 per cent of the total generated; however, in the great majority of plants the percentage is likely to be around 3 per cent.

Steam which is used for atomization is an entire loss. Entering the furnace with the oil spray, it is heated up to the furnace temperature which it materially lowers, greatly increases the volume of furnace gases, thereby taxing the available draft, and passes on through the boiler and out the stack carrying its heat with it. Condensation of moisture occurs at points of low temperature, where it causes the soot to bake in hard layers upon the boiler and economizer surfaces. In the case of oil fired furnaces, such condensation, mixing with the sulphur dioxide and other sulphur compounds formed by the combustion of the fuel oil, causes the formation of destructive sulphurous and sulphuric acids which corrode the metallic surfaces upon which they are deposited. In addition to these objections it has been found that in some cases the atomizing steam increases the spalling of the fire brick and the furnace lining. The cooling effect of the steam tends to cause the formation of disturbing deposits of unburned carbon which cling to the burner tips and to the interior surfaces of the furnace.

In recent years many developments have been made in the art of the proper combustion of liquid fuels and a number of systems have been perfected wherein the fuel oil is atomized mechanically without the aid of steam or air jets.

In this type of apparatus, which is known as the mechanical atomizer, the oil spray is produced by means of the oil pressure only. In this type of atomizer the hot fuel oil is given a rapidly whirling motion inside the burner tip and leaves the orifice of the tip as a conical spray of finely divided particles of oil, the spraying effect being produced by centrifugal force. Air for combustion enters the furnace at the same time, also with a whirling motion imparted to it by the form of the air entrance around the burner, and becomes intimately mixed with the oil spray. In this type of apparatus, as in the case of the steam or air atomized spray, the effectiveness of the results obtained depends largely upon the character of the spray, but to even a greater extent upon the manner of admitting the air for com-

bustion and the proportionate amount that is used. Here, again, the form and volume of the furnace are important factors.

As will be noted from Fig. 3, which represents a typical type of mechanical atomizer, the integral parts consist of a cast iron bladed cone (1), and a main register casting (2), which is bolted directly to the boiler front plate, thus holding the cone in place. In this type of apparatus the main register casting is fitted with four automatic air doors (3), by the use of which the quantity of air supplied to the burner may be regulated at will and shut off entirely if desired. These doors are so designed that they will close automatically in case of a flare-back in the furnace or the bursting of a boiler tube, thus protecting the fireman who may be standing in front of the boiler.

To the front of the register casting is fastened a cover plate (4), which is fastened with studs to the main register casting and holds in place the radiation guard (5), and the spider casting (6). This spider has four cams which control the operation of the automatic fire doors (3). Fastened to the spider (6), and passing through a slot in the cover plate (4), is a handle (7), to facilitate the operation of the spider. By moving this lever to the extreme right, the air doors are all closed, and by moving it to the left the doors are gradually opened.

Passing through the center opening in the cover plate (4) is a distance piece (8), to the room end of which is fastened a quick detachable yoke (10), and coupling (9); to the other end of this distance piece is fastened a cast iron conical shaped impeller plate (11). Passing through the center of the distance piece (8) is a mechanical atomizer (13), which is held in place and connected to the fuel oil supply line through the quick detachable yoke and coupling, thus making the atomizer, the distance piece and the center impeller a rigid unit when the apparatus is in operation. The distance piece is so designed that it may be moved along its axle, thus moving the center impeller in and out of the bladed cone, and thereby decreasing or enlarging at will the clear air space or the clear area for the passage of air, around the outside of the center impeller. Thus by pushing the center impeller in, toward the furnace, this clear area is considerably reduced, and by pulling it out to the position in which it is shown in Fig. 3, the maximum clear area will be obtained. By means of a set screw the center impeller together with the distance piece and the atomizer may be fastened in any desired position.

To adjust the distance between the tip of the atomizer (13), and the small opening in the center of the cast-iron impeller (11), the set-screw (14) is unscrewed, and, holding the distance piece (8), with the set-screw (12), the coupling may be rotated on the distance piece to any position desired. The distance between the tip of the atomizer and the small opening in the center of the cast-iron impeller should be maintained at approximately ¼ in., and when the coupling (9) is moved up to the distance piece (8) sufficiently to bring about this condition, the set-screw (14) should be driven home. If this adjustment has once been made, it should never have to be repeated. It is important that all such burners shall have had this adjustment made before they are first lighted up.

Besides the atomizer, other important and essential units of the mechanical atomizing system are the oil strainers, the pumps and the heaters. There are, of course, the necessary steam and oil piping and fittings as well as the essential accessories, such as fuel oil pump governors, reducing, relief and control valves, steam traps, thermometers and pressure gages.

A popular strainer is a duplex unit which consists of single castings containing two wells, into each of which a double basket strainer is inserted from the top, and held securely in place by the top cover which may be either screwed or clamped. Between the two strainer wells, in the center of the casting, is placed a three-way cock, which is so arranged that a quarter turn of the lever handle will divert the oil stream from passing through one of the baskets to the other, and at the same time cut the former basket entirely out of service so that it may be removed and cleaned without interrupting the service. At no position of the valve will the oil stream be stopped but will be flowing through either one or the other of the baskets and during the transition

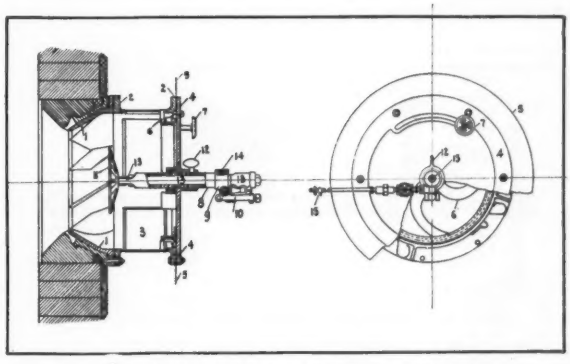


FIG. 2. MECHANICAL ATOMIZER OIL BURNER

period of making the change from one to the other it will pass partly through both. This feature is important inasmuch as any stoppage of the oil stream would of course extinguish all of the fires, and all such incidents should be avoided.

Fuel oil pumps may be either twin duplex reciprocating steam pumps fitted with air cushion chambers or they may be rotary, centrifugal, or geared plunger pumps, in any case fitted with proper air cushion chambers, automatic pressure regulators, control and relief valves. It is essential that there be no excessive pulsations in the pressure of the fuel oil, for the reason that any such pulsations will be greatly magnified in the operation of the burners and will tend to produce vibrations in the furnace which may be detrimental and possibly serious in their effect upon the brickwork. The best arrangement of pumps and regulator is that which produces a steady, uniform and adequate supply of fuel oil.

The multi-unit film oil heaters, which are frequently used, consist of welded steel tanks with double walls enclosing a helical coil of seamless steel tubing, with steam and oil outlets for connection to the steam and oil headers. The heaters are designed to combine strength, flexibility and efficiency with compactness and light weight. In operation, the fuel oil entering the heater unit between the two shells takes a spiral course upward (thereby absorbing much heat that would other-

wise be radiated) to the space between the two shell heads, from whence it flows down through the seamless steel coil and out to the discharge header. The live steam which is used for heating is passed up through the center of the tank, thence passing downward around the coil and out to the steam discharge header. In the event of an operator closing the inlet and outlet oil valves without cutting out the steam to the heater, thereby causing the dead oil in the unit to heat and expand to a pressure which might create a rupture, a safety valve should be provided with each unit which is set to operate before an excessive pressure can be attained. The capacity of such units runs from 750 to 1000 lb. of fuel oil per hour.

In the mechanical atomization of fuel oil, two important factors of operation are the pressure and temperature at which the oil must be maintained. The heavier the oil, the higher the temperature to which it must be raised in order to reduce the viscosity sufficiently to produce satisfactory mechanical atomization with a given pressure.

Viscosity, expressed in degrees Engler, is a measure of the fluidity of the oil. The less the number of degrees

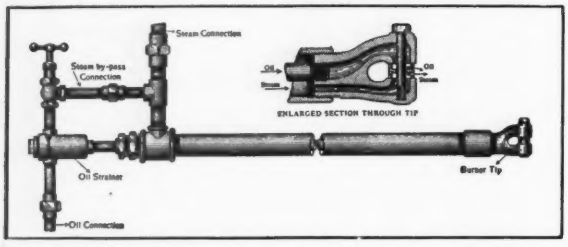


FIG. 3. EXTERNAL MIXING TYPE OF OIL BURNER

Engler, the more fluid the oil. Thus fuel oil at 50 deg. is altogether too viscous to be atomized in this type of burner, whereas an oil of 8 deg. or less can be readily atomized. Usually it is preferable to carry the viscosity of the fuel oil at a little less than 8 deg., generally about 5 to 7 deg. Engler.

In case the gravity of the fuel oil is known, expressed in degrees Beaumé, and no equipment is at hand for determining the viscosity of the oil, the following approximate values may be of service in deciding upon the proper temperatures to which to heat the fuel oil in order to obtain satisfactory atomization with the mechanical atomizing apparatus. In actual service, a little experimenting with the oil temperature is the best guide and the operator will soon learn to know the temperature below which an oil cannot be carried and still give satisfactory results.

"Tops," or stove distillate can be used at atmospheric temperature. Light oils, such as those from the Texas fields, require a temperature of from 100 to 210 deg. F. California residuum fuel oils can be used at temperatures varying from 210 to 270 deg. F. Heavy Mexican oils, in order to be satisfactorily atomized with the mechanical apparatus, must be raised to temperatures varying from 275 to 300 deg. F., depending upon the grade.

If the temperature of the oil is too low, the burner will smoke heavily due to the poor atomization produced. No amount of air will thoroughly clear up this smoke, and it will be impossible to obtain satisfactory results until the temperature of the oil is raised to the proper point. It is absolutely essential that the fuel oil be maintained at the proper working temperature so that the mechanical atomizer can, by means of centrifugal motion, produce the whirling cone of finely divided particles. Heating the oil much above the temperature

Gravity of the Oil Degrees Beaumé	Minimum Working Temperature Deg. F.
24—30	80—100
20—24	100—140
17—20	140—160
15—17	180—190
14—16	200—220
11—13	240—275

required for satisfactory atomization has a tendency to vaporize it and cause pulsations in the flame which cause vibrations and pulsations in the entire furnace, even when no smoke is being made. This condition is undesirable for the reason that it is detrimental to the brickwork of the boiler and also that it impairs the efficiency of the combustion by greatly varying the draft conditions of the furnace. From a commercial point of view it is undesirable to carry the temperature of the fuel oil at too high a point as this condition creates an unnecessary and wasteful demand for the live steam used for heating the fuel oil. It is, of course, true also that the higher the temperature of the fuel oil, the greater the radiation of heat from the heaters, piping, etc., no matter how perfect or efficient the insulation.

In this connection, it may be stated as a fact that a decided reduction in the capacity of a mechanical atomizer takes place when the temperature of the fuel oil is carried at too high a point. This is due to the fact that the heating of the oil increases its volume, so that, even though such heating renders it more fluid, a smaller quantity by weight is actually forced through the atomizer. Tests have shown that the capacity of a mechanical atomizer may be reduced nearly 50 lb. per hour, if the temperature of the fuel oil is carried at a point 100 deg. F. in excess of the proper temperature. It is obviously important that observations be made to determine the lowest point to which the temperature of the fuel oil may be carried and still be completely and satisfactorily atomized. The oil temperature should then be carried about 10 to 15 deg. higher than this minimum point.

DEPARTMENT OF COMMERCE has presented preliminary figures relating to the kilowatt-hours of electric current generated by central electrical light and power stations, both commercial and municipal, and by electric railways, in 1922, as compared with 1917 and 1912. These figures do not include the output of electric plants operated by mines, factories, hotels, etc., which generate for their own consumption, or those operated by the Federal Government and state institutions. The amount of current generated in 1922 aggregated 45,307,536,711 kw.-hr., as compared with 32,678,806,061 kw.-hr. in 1917 and 17,621,808,893 kw.-hr. in 1912, an increase of 38.6 per cent from 1917 to 1922, and of 157.1 per cent for the 10-yr. period 1912 to 1922.

Examples in Building Up Boiler Efficiency

A Few Typical Cases, Showing the Savings that May Be Effected by Simple Changes in Small Power Plants. By R. C. Demary*

IN A PREVIOUS article, I mentioned conditions found in the average power plant of 100 to 1000 hp. I mentioned the low efficiency and the lack of instruments by which efficiency could be built up. It is now my purpose to describe a plant in which the efficiency was built up from 42 per cent to not less than 68 per cent, which is considered good under the load conditions and the fact that the boilers were hand-fired.

When this plant was first visited, conditions were similar to those found in the average plant. The boilers, two 72-in. by 18-ft. horizontal return tubular, were badly scaled, a large number of steam leaks were in evidence, brick work bad, and while the plant was a model for cleanliness, it showed a general run-down condition.

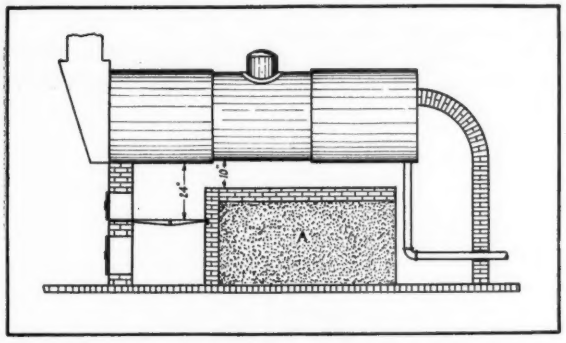


FIG. 1. THE MATERIAL AT "A" WAS REMOVED TO ENLARGE THE COMBUSTION SPACE

While the Department of Smoke Abatement in the city of Akron is concerned with the abatement of smoke, it has been the policy of the Chief Inspector to aid in building up the efficiency of the different power plants and in so doing, not only abate the smoke but conserve fuel.

In the plant referred to a CO_2 reading showed only about 4 per cent (this was like so much Greek to the engineer), so the matter of combustion was thoroughly explained to the man in charge, as was also the importance of having such instruments as were necessary to check up the efficiency.

Draft gages were attached to the boilers and the low CO_2 showed that there was considerable air leakage. The walls were thoroughly covered with a plastic coating and the percentage of CO_2 jumped to 8 per cent. Both boilers were set as shown in Fig. 1. The material at A, back of the bridge wall, was removed in order to enlarge the combustion space and the distance between the bridge wall and the boiler shell increased to 24 in. The damper was repaired so that the draft could be regulated by it instead by the ash pit doors as was the former practice. These few changes, and the CO_2 was increased to 10 per cent.

In other words, the plant, when operating under conditions as when first visited, showed a preventable fuel loss of not less than 24.21 per cent. At a cost of $63, this preventable loss was reduced to 5.69 per cent and the over-all efficiency after making several careful tests was increased from 42 to 68 per cent.

*Chief Smoke Inspector, Akron, O.

Ice Plant Adopts Bonus System

In another instance a large ice plant complained to the smoke inspection department of the high operating costs, and asked for advice. The plant consisted of two 300-hp. and one 600-hp. water-tube boilers, stoker fired. While conditions were better than the average, there was room for improvement. As usual, there were no instruments by which the draft carried or the CO_2 content of the gases could be measured. Department tests showed the CO_2 to vary from 5 to 8 per cent. The advisability of securing proper instruments was taken up with the management and the result was the purchase of draft gages and a recording CO_2 meter was installed where the fireman could at all times keep his eye on it. A bonus system was worked out and adopted, as follows:

Per cent CO_2	Premium per day
12	$0.75
11.5	0.70
11	0.65
10.5	0.60
10	0.55
9.5	0.50
9	0.45
8.5	0.40
8	0.35
7.5	0.30
7	0.25

A typical chart from the recording CO_2 meter is shown in Fig. 2.

Careful records show that since the adoption of this system and the installation of the instruments at least 30 per cent of the coal bill has been saved. The men are paid 10 per cent of the saving effected leaving a net saving to the company of 27 per cent with no further investment than the small cost of the apparatus.

In conversation with the superintendent, he said: "I had much rather give that money to the firemen than to the coal dealer."

At the time of adopting the bonus system standards of furnace operation to insure best results were also adopted. These standards were classified according to the following items:

1. Method of operating stokers to avoid faults in fuel bed and to keep fuel bed at proper depth.
2. What draft to use at normal load and variation of draft for changes in load.
3. Proper method of using firing tools.
4. Proper method of cleaning fires.

With a thorough understanding of these four fundamentals, and a more consistent watch on furnace conditions the matter of obtaining and holding high efficiency was comparatively easy.

The manager of another plant called the writer on the 'phone one morning and requested a visit to the plant as something was wrong. "We are burning too much fuel," he said, "and want the department's ad-

vice." The plant consisted of two 72 in. by 18 ft. h.r.t. boilers only one of which was used at a time, the second being kept in reserve. Figures showed a very high coal consumption and the complaint was justified.

Steam was used for certain process work and all returns were piped into an improvised tank. Two small single acting pumps were used for boiler feeding, one taking its suction from the tank or "hot well' as the engineer called it, the other taking water from the city mains.

In looking over the layout, a bypass valve leading to the sewer was discovered on the discharge line of the pump using the hot water. This valve was set at 40 lb. Up to that pressure the hot well pump furnished all the make-up water necessary. Above that pressure, it became necessary to cut in the other pump. As 100-lb. pressure was carried on the boilers all returns were being pumped into the sewer and feed water was entering the boiler at a temperature of about 60 deg. F.

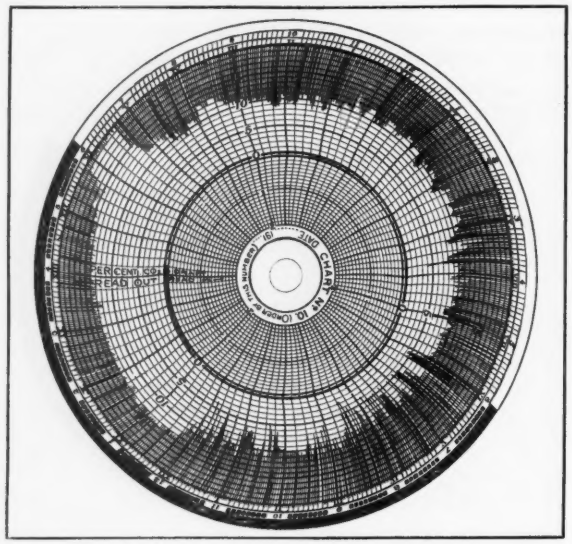


FIG. 2. A TYPICAL CO_2 CHART, AFTER THE BONUS SYSTEM WAS INSTALLED

As soon as this condition of affairs was discovered the bypass valve was properly set at the required pressure and now only on rare occasions is city water used. A small amount of make-up water, of course, is required; but this is run into the hot well so that the temperature is raised well above 100 deg. F., the average temperature of the water in the well being 165 deg. F.

This condition had existed for a period of over 5 yr., during which time millions of gallons of hot water had gone into the sewer and cold water into the boiler. A check on the operating figures showed a saving of approximately 2 T. of coal each day and taking this over a period of 5 yr. at the average number of days the factory was in operation and at the average cost, it shows a loss of nearly $12,000, which is no small item.

This condition existed not because of ignorance, but because of negligence on the part of the engineer and the superintendent, who considers himself one of the best posted mechanics in the country. This same superintendent, in discussing pulverized fuel with the writer, said it might be all right in some places but it "was mighty hard on the grates."

Operating a plant under the conditions mentioned in this article is nothing short of criminal when the enormous waste of one of our nation's greatest resources and one that cannot be replenished is considered.

The Best Speed for a Belt*

By W. F. Schaphorst

THERE IS no question that centrifugal force will "explode" any belt, if the speed of the belt is high enough. I have figured, for instance, that a leather belt of 1000 lb. breaking strength per square inch will explode without pulling an ounce of load when running a trifle over 3 mi. per min. It is evident, then, that 3 mi. per min. is too fast. No use running a belt and pulleys at that speed if they refuse to do anything but tear themselves to pieces. Also, a belt won't do anything when it isn't moving—when its velocity is zero. Therefore, somewhere between zero velocity and 3 mi. per min. there is a "best belt speed," and at that speed the belt will transmit the most power.

To determine the best speed for any belt of known safe strength, I have prepared the accompanying chart.

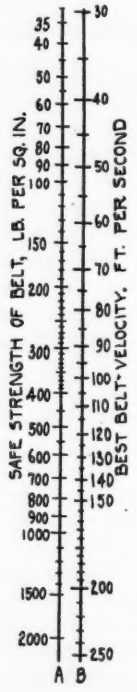


CHART FOR DETERMINING BELT SPEEDS

Find the safe strength of the belt in column A. Column B will then give the best velocity. All you need do is glance across from column A to column B.

For example, if the safe strength is 200 lb. per sq. in. (which would be a second class leather belt), the best velocity is 74 ft. per sec. The chart's range is wide enough to include every possible strength for leather.

Since cotton and canvas belts often weigh the same per cubic inch as leather belts this chart is equally applicable to such weight belts. It is assumed here that the best is not subject to needless initial tension in addi-

*All rights reserved by author.

tion to the tension of centrifugal force and the load tension on the tight side. If initial tension is practiced, it is difficult to tell just what the best speed would be, because such practice sometimes breaks belts even before they do any work at all. Certainly, high initial tension reduces the best speed to a much lower figure than given in this chart.

This chart, therefore, should prove to be an important aid in the selection of belts and pulleys. It shows clearly the advantages of strong belts, and high speed means high power. It shows that new strong belts should be run at high speed. As they grow older and weaker, they can be used on slower drives and replaced on the high speed drive by new and stronger belts.

Lubricating the Eccentrics

By A. R. Knapp

ALMOST EVERY engineer has had at some time during his career to contend with a hot engine eccentric. Eccentrics that are light in weight and run at a moderate speed may never give trouble from this cause. The incident about which this article is written occurred on a 14 by 24-in. Corliss engine running at a speed of 215 r.p.m. With this type of engine, the intake and exhaust valves are controlled by separate eccentrics.

These eccentrics are large and heavy, and at the speed given above, the matter of proper lubrication became a problem. These eccentrics ran fairly well in cold weather; but during the summer when the temperature of the engine room often reached 120 deg., these bearings tested the patience of the entire engine room crew. The eccentrics were shop equipped with force feed grease cups. Various grades and kinds of grease were tried, but the trouble continued. As it was necessary for the engine to run continually throughout the day, the cups had to be filled before the day's run. It was almost impossible to set the cups so that the grease fed regularly. Often the small hole in the cup would clog in various ways, and if the attendant was not close by, the eccentric would heat before the emergency feed could be operated. They were frequently taken down, examined, and made certain they were not too tight.

Finally it was decided to replace the grease feed with oil. The problem then arose as to the best way to lubricate these high speed eccentrics. The arrangement shown in Fig. 1 was worked out. In the drawing only one eccentric is shown for the sake of clearness. The grease cup was removed and ½-in. ells and nipples substituted as shown at B. The oblong funnel A was made of thin galvanized iron and securely soldered into the ell. This funnel is shown in detail in Fig. 2. All joints were carefully soldered, and a ½-in. lip soldered around the top edge as shown at X to prevent the oil being thrown out of the funnel. C is a small angle iron screwed to the ell and to the eccentric top for the purpose of holding the funnel upright.

This funnel should be made long enough to catch the oil drips while the engine is being brought up to speed. Once up to speed the throw of the eccentric is reduced considerably and there is little danger of oil missing the funnel. A hole was drilled through the sheet iron hood over the eccentrics, and sight feed oil cups installed directly over the funnel centers. These cups were held securely in place by the nut E.

It was found necessary to solder a piece of small tubing F to the bottom of the oil cup to conduct the oil to the funnel. Without this tube, the draft of air through the hood produced by the flywheel would cause a deflection of the oil drops.

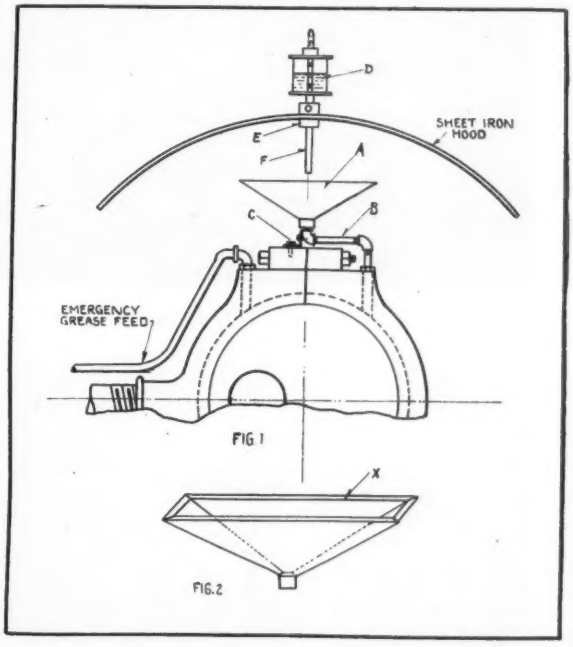


FIG. 1. SIDE VIEW OF ECCENTRICS SHOWING METHOD OF OILING

FIG. 2. DETAIL OF FUNNEL CONSTRUCTION

This oil feed has now been in operation for more than a year, and every one about the plant except the oiler has forgotten that the engine has eccentrics.

Organization Load Factor

DESIRABILITY of high load factor for a power plant is well understood if best efficiency and economy are to be secured from equipment. But do plant managers also give attention to getting a high load factor of the operating force?

Routine operation is the steady load which cannot be varied much; emergency repairs will bring in peaks which cannot be avoided; but inspection, alterations, additions and overhauling can, by using foresight, be so planned as to fill into the valleys of the operating load line and keep off the peaks.

Steady, regular working rather than periods of rush work followed by slack periods makes for well performed duties and effectiveness of employes.

Careful survey of future needs by the plant manager and logical planning to meet those needs will secure results well worth the time spent.

ESPRIT-DE-CORPS is that spirit of teamwork in an organization which "puts it over the top."

Constructing the Power

RECENT PHOTOGRAPHS SHOW RAPID
THE CRAWFORD STATION OF THE COM

We present on these pages some of the most recent photographs of the new Crawford Ave. Station. Since the publication of the last set of photographs in the Sept. 15 issue, great strides have been made in construction work, and the steel and concrete frame work is beginning to assume definite form. Most excavating operations have been completed, and many of the buildings will soon be sufficiently completed to permit the installation of equipment.

In Fig. 1 is shown a view of the oil switch house as it was on Aug. 28. This will be the first part of the project to be completed, as it is the intention of the company to use Crawford as a switching center until the remainder of the plant is completed.

Figure 2 shows the steel frame work of the transformer house being erected immediately adjacent to the switch house. Part of this construction is also shown on Fig. 1. Figure 2, however, was taken on Sept. 11, and shows the progress made since Aug. 28.

The construction of the discharge tunnel is an important part of the project and requires a considerable amount of excavation as may be seen in Fig. 3.

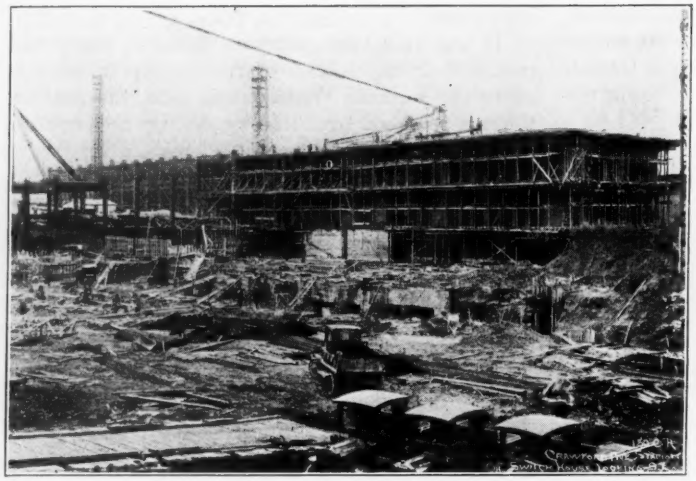


Fig. 1. Oil switch house looking S. E.

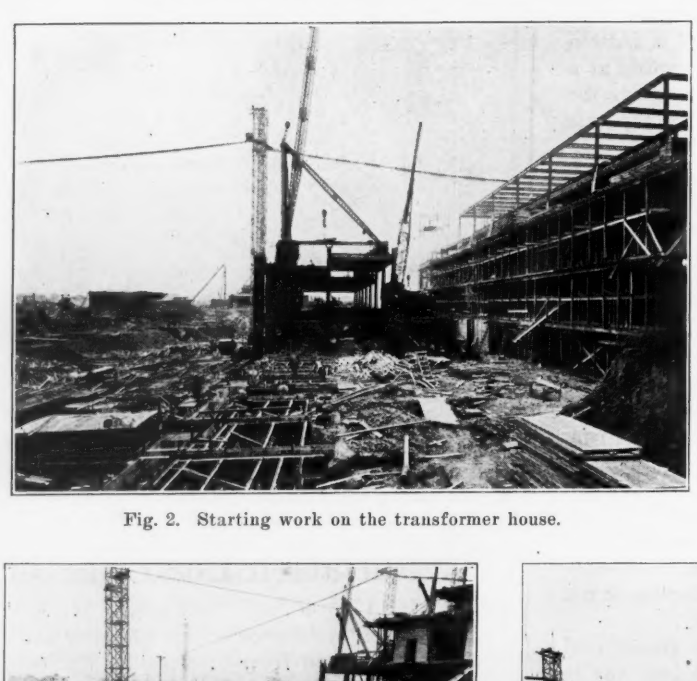


Fig. 2. Starting work on the transformer house.

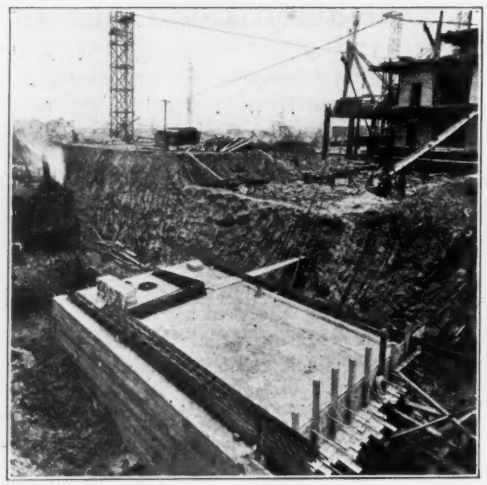


Fig. 3. A section of the discharge tunnel

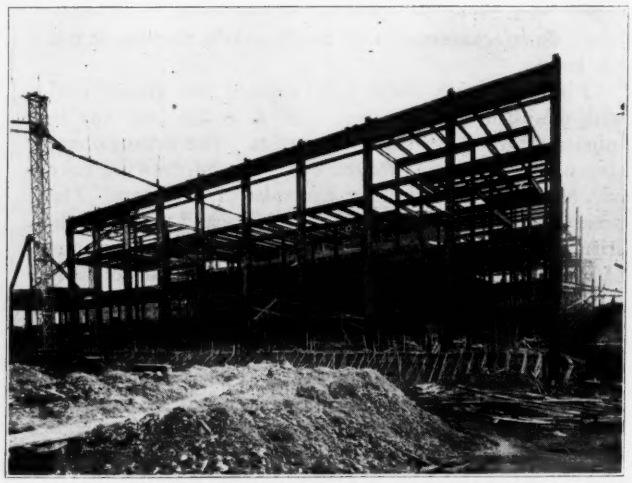


Fig. 4. Turbine room looking S. E.

World's Largest Station

PROGRESS IN THE CONSTRUCTION OF MONWEALTH EDISON CO., OF CHICAGO

This tunnel, as may be noted, is built entirely of reinforced concrete, and is square in cross section. It will discharge directly into the drainage canal on the bank of which Crawford Station is being erected.

Figure 4 shows the steel for the south wall of the turbine room in course of erection on Sept. 24, while in Fig. 5 is shown a view of the excavation for the crib house. The discharge tunnel is also shown in this photograph. Some idea of the tremendous size of this excavation may be had by noting the relative size of the workmen in the left center of the photograph.

Another view of the discharge tunnel is depicted in Fig. 6, and in Fig. 7 is a close up view of the south wall of the switch house. The latter view illustrates the details of construction to good advantage. In Fig. 8 may be seen the court between the switch house and transformer house.

All of the photographs shown herewith were taken by A. R. Gerlach, official photographer of the Commonwealth Edison Co., and are reproduced on these pages by special permission.

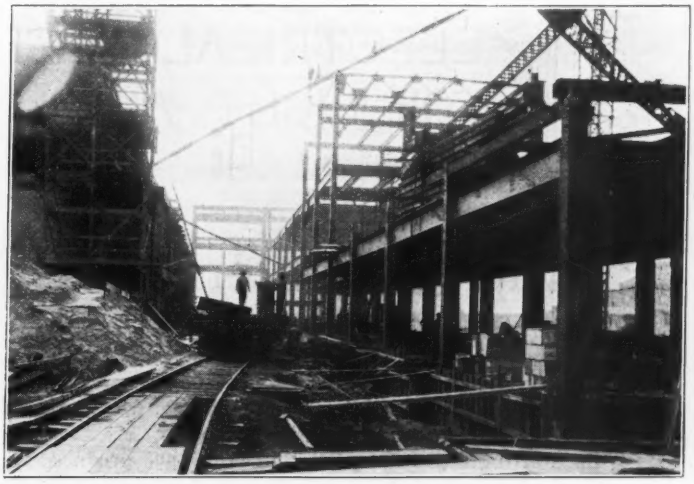


Fig. 8. View between switch and transformer house.

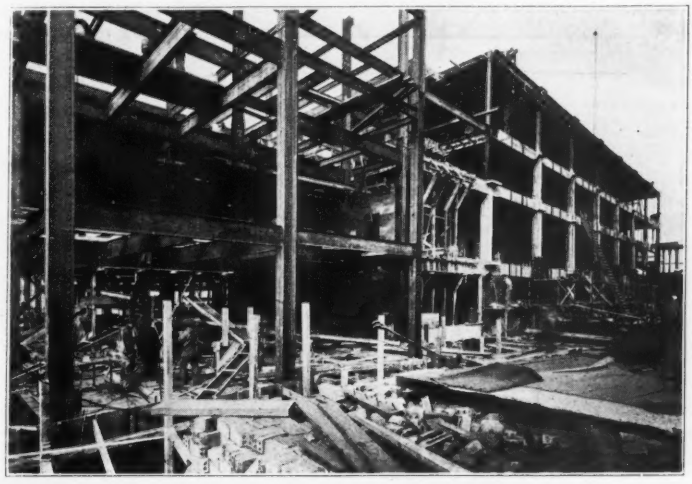


Fig. 7. Details of the switch house.

Fig. 5. Preliminary work on crib house.

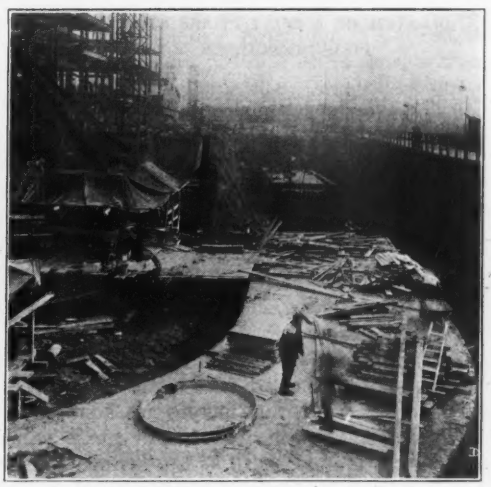
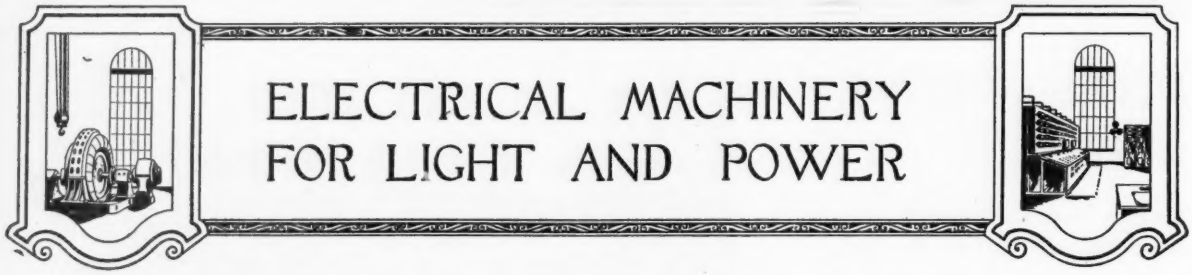


Fig. 6. Another view of discharge tunnel.



Principles of Alternating Current Control

PART I. SINGLE PHASE MOTORS, POLYPHASE MOTORS AND SQUIRREL CAGE INDUCTION MOTORS. BY GORDON FOX

MOST ALTERNATING current motors, like those for direct current, are designed primarily with a view to running performance. To provide proper conditions during the starting interval, a controller is necessary. The control requirements differ with the different motor types. In this article we will consider the following types:

Single phase motors, polyphase motors, squirrel cage induction motors, wound rotor induction motors and synchronous motors.

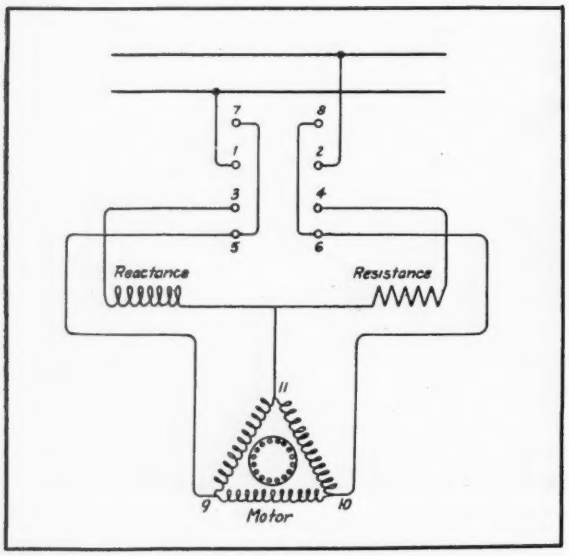


FIG. 1. DIAGRAM OF A SPLIT PHASE STARTER FOR SINGLE-PHASE INDUCTION MOTOR

SINGLE-PHASE MOTORS

Small single-phase motors are of several types, series motors and shunt induction motors being the more common. It is desirable for the sake of simplicity, that motors of small size be started by merely connecting them to the service lines. Series motors are well suited to this purpose. Induction motors are adapted to this method of starting by means of split phase windings, self contained. Motors up to ⅓ hp. rating, designed in this manner, may be thrown directly upon the power lines with no ill effect. Induction motors of larger size are commonly equipped with a split phase starter. These motors have multiphase primary windings. The split phase starter serves to supply "out of phase" current to the different phase windings of the motor, creating a revolving field about the stator similar to that produced in a multiphase motor. A diagram of a split phase starter is shown in Fig. 1. These motors develop only moderate starting torque and require rather heavy starting current. "Repulsion" motors and combination designs are built capable of connection directly across the power lines in sizes up to about 5 hp. Rheostatic starters are supplied with some of the larger motors, to reduce starting currents.

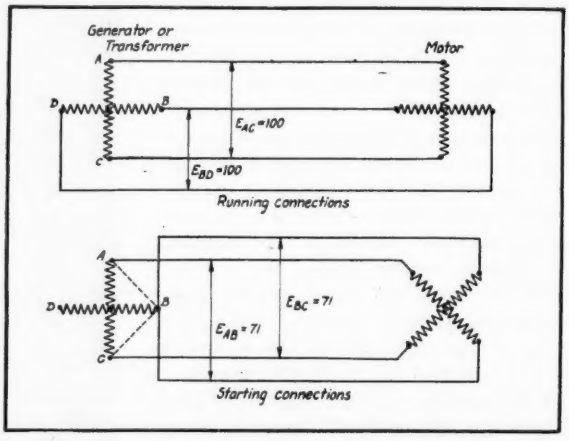


FIG. 2. CONNECTIONS FOR INDUCTION MOTOR OR INTERCONNECTED TWO-PHASE CIRCUIT TO OBTAIN REDUCED STARTING VOLTAGE

Specialized types of "repulsion-induction" motors are designed for reversing or varying speed service. Some of these motors depend upon brush shifting for their control, a shifting lever being mechanically connected to the brush yoke of the motor. Other types require drum controller, which reverse portions of the stator winding to reverse the rotation and insert resistance in the stator and rotor circuits to increase and decrease the motor speed.

POLYPHASE MOTORS—THE SQUIRREL CAGE INDUCTION MOTOR

Starting with full primary voltage. When voltage is applied to the primary windings of a polyphase induction motor, the revolving field, traveling at synchronous speed, is set up instantly around the air gap. As the rotor is at stand still, the rotor slip is high. The re-

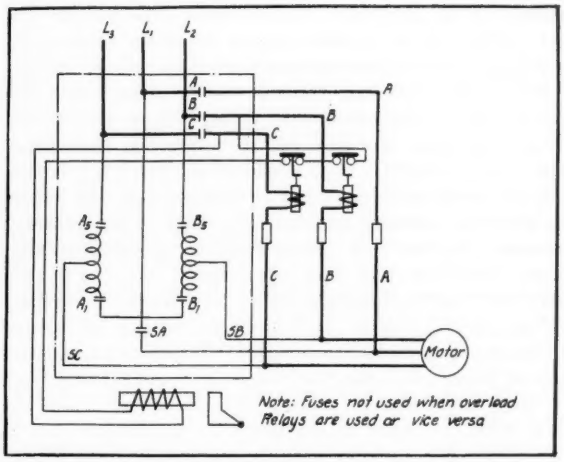


FIG. 3. AUTO STARTER WITH TWO COIL AUTO TRANSFORMER

volving flux cuts the rotor conductors rapidly and sets up in them a relatively high voltage. The current which flows in the rotor conductors due to this voltage is restricted only by the rotor resistance and reactance and the heavy current thus set up in the rotor causes a large current to be taken by the primary, due to transformer action.

Any standard squirrel cage induction motor, connected directly across full voltage, will draw from 500 to 700 per cent rated full load current and will develop 125 to 175 per cent full load torque. This inrush of current is only momentary and the current falls rapidly as the motor attains speed. The magnitude of the first rush of starting current depends upon electrical factors only and is independent of the mechanical motor load. The duration of the starting peak, however, depends upon the time required for acceleration which, in turn, depends upon the mechanical load.

Squirrel cage motors of the high resistance rotor type, such as are used for elevator service, will take about 250 to 300 per cent rated full load primary current and develop about 150 to 200 per cent full load torque if connected directly to full voltage. Motors of this class have a slip of about 15 per cent at full load.

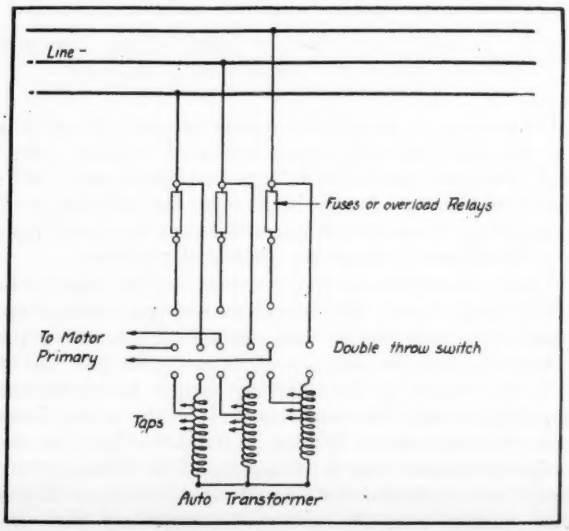


FIG. 4. CONNECTIONS FOR AUTO STARTER WITH 3-COIL AUTO TRANSFORMER

Starting with Reduced Primary Voltage

As a current 5 to 7 times normal is too severe upon the motor lines and the resulting starting impulse too sudden, it is necessary to reduce this effect. This can be done, in the case of the squirrel cage motor, only by reducing the impressed primary voltage. The exact values of starting currents and torques produced with different impressed voltages depend upon the motor characteristics. The following values are typical, however, for standard squirrel cage motors:

TABLE I. INDUCTION MOTOR STARTING PERFORMANCE

Impressed voltage Per cent rated volts	Starting current input to motor Per cent full load current	Starting torque Per cent full load torque
100	600	175
90	550	150
80	480	110
70	420	80
60	360	60
50	300	40

Starting Transformers

Reduced voltage for use in starting squirrel cage motors may be provided in several ways. Where transformers are used for the power supply of one or more motors it is possible to take off reduced potential from taps in the secondary winding. Additional leads are run from these taps. The controller merely provides for switching, first to the low voltage taps, then to full voltage lines. If standard transformers are used, a starting voltage of 50 per cent full voltage may be readily provided. At this voltage, the motors will develop about 40 per cent full load torque at starting. This is insufficient in many instances, but is satisfactory in some cases. By means of special taps in the transformers a higher starting potential may be provided and better torques obtained from the motors. This method of securing reduced starting potentials is not extensively employed, but it offers possibilities of considerable saving in cost of controllers where conditions are favorable. It is quite commonlly employed where transformers are provided to supply single units as in the case of synchronous motors or converters started by induction motor action from the alternating current side.

Where a two-phase interconnected power system is used, a starting voltage 71 per cent of line voltage may be obtained by interconnecting the phase loads, as indicated in Fig. 2. A double throw starting switch or controller is necessary. No extra power supply lines are necessary.

A reduced potential for starting squirrel cage induction motors may be obtained by providing small transformers for each motor together with means for connecting the motor first to a reduced potential taken from the transformers and then to the lines. Either polyphase transformers or a combination of single phase transformers may be used. These transformers commonly take the form of auto-transformers, to reduce their cost. Starters operating on this principle are

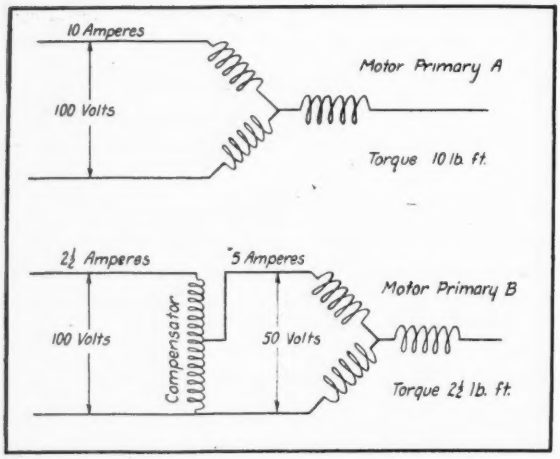


FIG. 5. INDUCTION MOTOR STARTING CURRENT WITH AND WITHOUT STARTING TRANSFORMERS

called auto-starters or starting compensators. It is customary to provide the auto transformers with several taps so that various starting voltages may be secured. Polyphase transformers may have either two or three coils. For two phase motors two coils only are necessary. For three phase motors two coils may be employed, connected open delta, or three coils may be used, being connected in Y. Figures 3 and 4 show the main connections for three phase compensators connected according to these two schemes. Single phase transformers are combined to obtain the equivalent result.

It is to be noted that, when auto transformers are used, the line current is less than the motor primary current in a degree depending upon the ratio of transformation. This condition will be readily seen by inspection of Fig. 5.

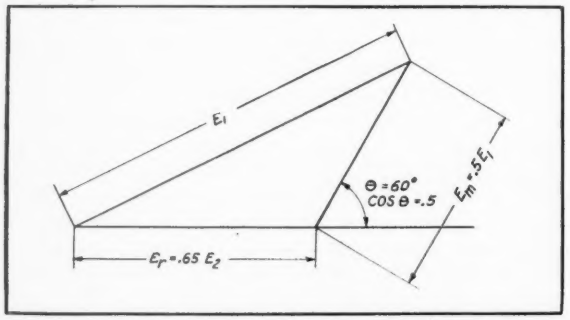


FIG. 6. DIAGRAM FOR DETERMINATION OF PRIMARY RESISTANCE

PRIMARY RESISTANCE STARTING

Reduction of impressed voltage may be secured by insertion of resistors in series with the primary windings of the motor. The amount of resistance may be adjusted to secure the desired starting voltage and torque. As the motor attains speed, the resistance may be cut out by short circuiting in one or more steps. This method differs distinctly from the auto transformer method in that the latter causes a reduced voltage of constant value to be impressed on the motor, whereas the voltage at the terminals of a motor in series with primary resistance varies according to the motor current. The initial current inrush causes a large drop in voltage through the resistors and the motor voltage is then relatively low. As the motor accelerates, the current input decreases, the voltage drop in the resistors decreases and the motor voltage is thus automatically increased. If the load is not heavy, it is possible to accelerate nearly to synchronous speed before the starting resistors are short circuited. The primary resistance starter has the marked advantages of simplicity, low first cost and easy repair. It is not necessary to interrupt the circuit to transfer from starting voltage to full voltage and the interruption of torque development is therefore avoided. It has the disadvantage of lower efficiency and larger current intake from the line, since motor current and line current are the same with this type of starter. It also has the disadvantage that an exceptional torque demand, which calls for increased current, causes increased resistance drop and decreased impressed voltage just when ample voltage is necessary. Partly because of the high line current taken, primary resistance starters have not been extensively used except for the smaller motors.

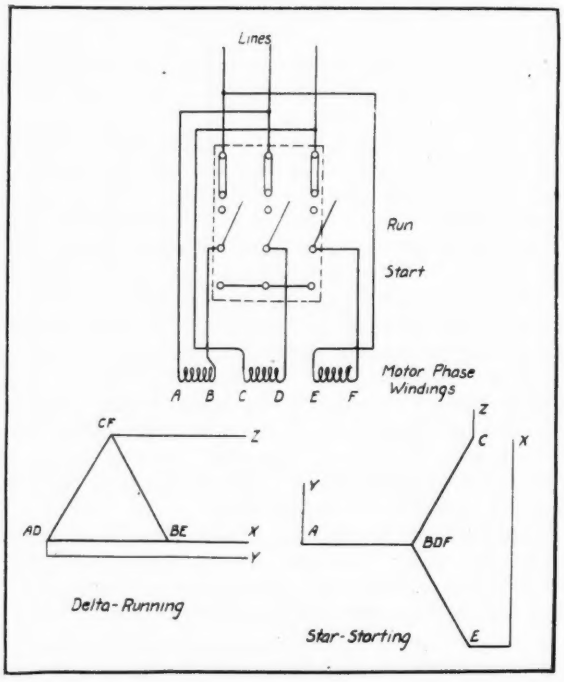


FIG. 7. STAR-DELTA STARTING OF THREE PHASE INDUCTION MOTOR CONNECTIONS AND VOLTAGE RELATIONS

For three-phase service, resistors may be inserted in two or three lines. For two-phase service, resistors are inserted in each phase. The method of calculating the primary resistance may be explained with the use of Fig. 6. Knowing the starting torque required, the starting voltage necessary may be determined from motor characteristics, bearing in mind the fact that the torque is proportional to the square of the primary voltage. Let us assume that it is desired to supply 50 per cent voltage with the motor at standstill. With the average squirrel cage motor, the inrush current when 50 per cent voltage is applied at starting, is about 300

per cent normal and the power factor at starting is about 50 per cent. Let E_1, Fig. 6, represent line voltage. Since the motor power factor at starting is 50 per cent, the motor voltage E_m may be laid off as indicated. The angle is 50 deg., since the cosine of 60 deg. (equals power factor) is .50. The voltage drop across the primary resistance will be E_r, which in this case equals 65 per cent of E_1. The resistance per phase will then be the voltage across the resistance E_r divided by the current. For three phase it is necessary to introduce the constant 1.73 because of the phase difference of line voltage and current. The resistance

$$R = \frac{E_r}{1 \times 1.73}$$

Where I = line current inrush.
R = resistance per phase.
Since, in this case, $E_r = .65\ E_1$

$$R = \frac{.65\ E_1}{1 \times 1.73}$$

If resistance is inserted in only two-phases, the above value of R must be increased 50 per cent.

It is possible to utilize a double connection of the motor primary windings to provide reduced starting potential. The primary windings of a three-phase motor may be brought out with both ends of each phase ending in a terminal at the motor. The six resulting terminals are connected to a double throw switch, usually of a modified drum type. The connections of this switch are such that, for the starting position, the line voltage is impressed upon the motor coils connected in star or Y, while, for the running position, the motor windings are connected in delta across the line. The voltage impressed upon each phase winding, star connected at starting, is thus 58 per cent of the voltage impressed upon the windings, delta connected for the running position. The starting current is proportionately reduced. This method is illustrated in Fig. 7, showing connections and voltage relations.

One disadvantage incident to this so-called star-delta starting method lies in the fact that the starting voltage can have but one value, namely 58 per cent of line voltage. Where the torque required for starting is at all heavy, this low voltage may prove insufficient. Another disadvantage lies in the necessity of winding the motors for delta connection for line voltage. There are some advantages for the Y connection which cannot be realized if this starting method is used. The advantage of the method lies in the simplicity and low cost of starting device.

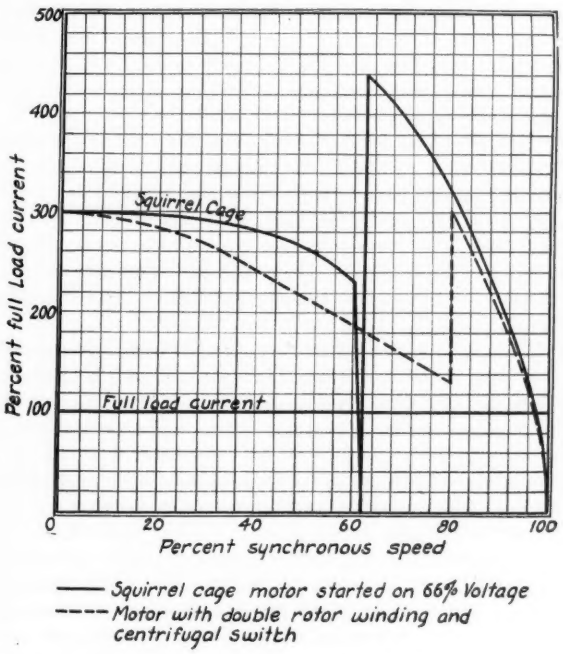


FIG. 8. CURRENT INPUT DURING ACCELERATION OF SQUIRREL CAGE AND "AUTOMATIC START" INDUCTION MOTORS

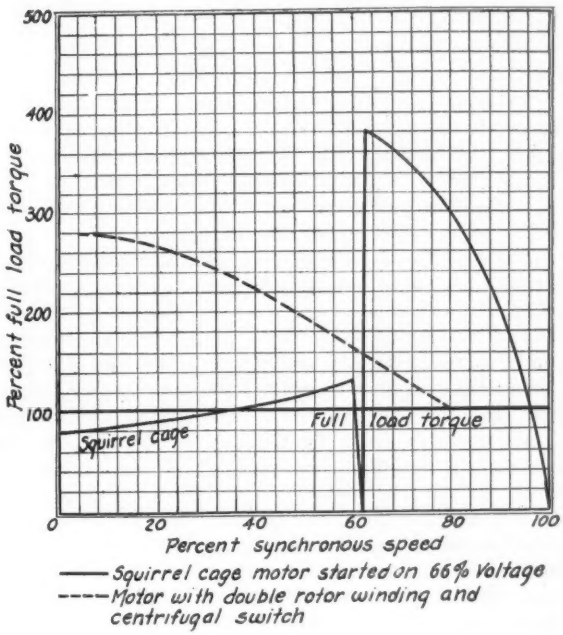


FIG. 9. TORQUE DEVELOPED DURING ACCELERATION OF "AUTOMATIC START" INDUCTION MOTOR

Starting current and torque: The current and torque conditions incident to the starting of a squirrel cage induction motor with auto starter may be visualized by inspection of Figs. 8 and 9, respectively. It will be noted that when 66 per cent voltage is impressed on this motor, approximately 300 per cent current flows and about 80 per cent of full load torque is developed. As the motor speed increases, the current falls off but the torque increases due primarily to decreasing rotor frequency and impedance. The figures indicate the transfer to full voltage as occurring at 62 per cent speed. Both the current and torque are greatly increased when full voltage is applied. If the motor reaches a higher speed before transfer to full voltage, these peaks are reduced. The dotted lines indicate the action of an "automatic start" motor with double rotor winding and centrifugal governor. This motor has a high resistance squirrel cage rotor winding for starting and a phase winding for running, the latter being cut in by short circuiting it by the centrifugal switch as the motor approaches full speed.

Inductive Alternating Current Circuits---II

General Considerations Regarding the Conception of the Term Power Factor. By E. K. McDowell*

IN AN alternating current circuit containing resistance only, that is, in a non-inductive circuit, the current will be in phase with the impressed electromotive force; i.e., the impressed e.m.f. will be the voltage that impels the current. In an inductive circuit, on the other hand, we have seen that the current is not in phase with the sending-end e.m.f., E., but lags behind E by some phase angle p, the magnitude of which depends upon the inductive reactance of the circuit. This e.m.f. E is the resultant of two components, E_x the reactive e.m.f. and E_1 the energy e.m.f. The current lags 90 deg. behind E_x but is in phase with the energy e.m.f. E_1: accordingly, the latter, and not the impressed e.m.f., will be the voltage that impels the current.

Furthermore, it can be shown that the reactive e.m.f. does not represent any actual power. This is probably sufficiently apparent by inspection of Fig. 1 on page 1037 of the Oct. 15 issue. Note thereon that the reactive e.m.f. curve is equally above and below the zero line during the half cycle shown, its average value during that period is therefore zero. Accordingly the product of the reactive e.m.f. by the average current for the half cycle is zero, and consequently it is zero for the full cycle.

It is evident, from the foregoing, that the true power in an inductive circuit is the energy-e.m.f. times the current. This may be understood by referring to Fig. 3 on page 1039 of the Oct. 15 issue. The impressed e.m.f. consists of two components; E_1 the energy e.m.f. and E_x the inductive e.m.f. The latter does not represent any power, or energy as has just been shown, therefore E_1, the energy-e.m.f. times the current in the circuit must represent the true power of the circuit; ie.,

$$P = E_1 I \quad \ldots\ldots\ldots\ldots\ldots\ldots (a)$$

but; from Fig. 3 (Oct. 15 issue) $E_1/E = \cos p$; where p is the phase angle by which the current lags behind the impressed e.m.f.

then $E_1 = E \cos p$, whence

$$P = I E \cos p \quad \ldots\ldots\ldots\ldots\ldots\ldots (b)$$

The quantity cos p is commonly referred to as the power factor of the circuit, since it represents the ratio of the "apparent power" (= I E, often referred to as kv.a.) to the true power $= I E_1$) of the circuit. Or writing pf for cos p as is customary, equation (b) can be written

$$P = I E \times pf \quad \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Since P = true power, and I E = apparent power, equation (16) can be written as

$$\frac{P}{I E} = \frac{\text{true power}}{\text{apparent power}} = pf$$

Power factor is generally expressed as a percentage equal to the ascertained or assumed value of cos p for the given circuit. The power factor of a strictly non-inductive circuit would be unity (100 per cent); for, in such case, the impressed (or sending-end) e.m.f. would equal the energy-e.m.f.; the reactive e.m.f. would be zero; and cos p would equal 1. For an inductive circuit where the inductive effects are all due to line reactance the power factor is decreased to some value less than unity; which depends upon the ratio of the reactive e.m.f., E_x, and the energy-e.m.f., E_1.

In other words, the greater the inductive reactance relative to the resistance of the circuit, the greater will be the reactive e.m.f. E_x relative to the energy-e.m.f. E_1 —thus increasing the lag angle p. As p increases from 0 deg. toward 90 deg. cos p will decrease from unity toward zero: thus the power factor of a circuit will be lower if the line reactance (ohms) is high relative to the line-resistance.

In the case of an inductive circuit with load (motors, lighting, etc.), connected thereto; it will be seen later on that the power factor of the circuit as a whole is subject to further reduction, as a result of added inductive effects from the connected load. As preliminary to outlining the properties of such circuits, it is necessary to consider, at this point, the general nature of load power factor.

This is a term used with reference to the entire load, or group of loads, connected to a circuit; and is the ratio equal to the true power, in kw. of effective energy supplied to the load, divided by the apparent power in kv.a. as at the receiving end of the circuit. This reduction of the apparent power comes about by reason of inductive effects, which take place to a greater or less degree practically in all a. c. electrical apparatus. In other words, the current, supplied to the motor (or other load) is "impeded" by self-induced-counter-e.m.f. set up in the windings of the apparatus; and is caused to lag behind the e.m.f. supplied to the load by some angle p_1. The cosine of p_1 then equals the load power factor, in the same way that cos p equals the power factor of the Fig. 4 (Oct. 15 issue) circuit. Accordingly, by similar reasoning to that preceding equation (16), we have

$$P_1 = I E_o \times pf_1$$

where P_1 is the true power in watts supplied to the load, I is the current, E_o the e.m.f. impressed on the load, and pf_1 is the load power factor; expressed as per cent (of unity).

This load power factor will also be referred to hereinafter as the receiving end power factor; likewise the e.m.f. E_o, impressed on the load, will be referred to usually as the receiving end e.m.f. On some circuits, having loads connected at different points along the length thereof, these two terms may appear to be inapplicable; since a considerable portion of the load may actually be located elsewhere than at the receiving end of the line. However, it is customary (and necessary) to arrange the calculation procedure somehow so that the load can be assumed to be concentrated at the receiving end. This can generally be done, without material error, by considering the "effective length" of the line as extending to the "center of gravity" of the loads.

Conditions Affecting Load Power Factor

The power factor of any particular a. c. load-unit; such as a motor, or a rotary converter, or any other certain class of apparatus, is dependent mainly upon the type of equipment and upon the character of the load;

*Chief engineer, Donora Steel Works, American Steel and Wire Co.

but can usually be assumed close enough for practical caulculation purposes, if based on average load conditions. For instance, the powwer factor of an induction motor operating at full-load under reasonably constant-load conditions would likely be about 80 per cent; but at partial load, or under fluctuating load, might be 60 per cent or less.

In the case of a mixed load, consisting of a number of units or groups, the aggregate load power factor can be arrived at by a certain vector-diagram method, provided that representative power factor values can be assigned to each component unit, or group.

General Significance of Low Power Factor

The general significance of low power factor is, as evident from equation (16), to increase the current to a value greater than that current which would transmit the same power at unity power factor. This additional wattless current (so-called) does not, however, represent any direct loss of power; for we have seen that the true power is the energy-e.m.f. times the current; accordingly the turbine or engine power required at the generator equals the kw. of the load, without regard to the power factor. That is, provided we neglect the usual inherent losses of the machine, together with certain minor losses incidental to the low power factor; in which connection it will be seen later that the wattless current is responsible for some relatively small power losses.

Effective capacities of generators are determined by the amperes of current that can be generated by them without overheating; and this heating effect is proportional to I^2R—i.e., to the square of the current. It is evident, then, that this excess current—due to low power factor—has the same heating effect as the power-current. The available capacity of the generator for power-generation is accordingly reduced by reason of the presence of this "wattless current." The available capacity of the transmission line is similarly reduced; since the line has to be proportioned mainly to carry a certain number of amperes of current with a certain allowable I^2R loss, manifested in voltage drop, power-loss, and heating.

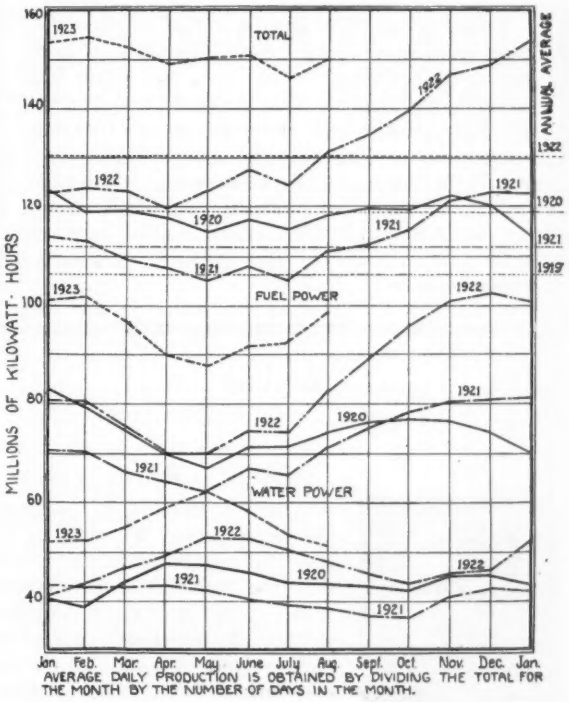
Furthermore, the inductive counter-e.m.f. associated (as has been outlined) with a low power factor current has a de-magnetizing effect on the generator fields. This requires additional exciting current, causing further heating of the generator and a reduction of efficiency thereof. These items: loss in efficiency, generation of additional exciting current, and additional I^2R loss in the transmission lines; all represent actual power-loss. Operating disadvantages are also involved at low power factor, due to poor voltage regulation with changes of load; with, in some cases, the possibility of motors stalling under load as a result of low voltage.

In general it is often said, practically speaking, that a power-distribution system should operate at 75 per cent power factor (or better) to secure favorable operating conditions. Low power factor can be corrected by the use of synchronous motors. This method, also the general subject of load power factor, will be referred to further in subsequent articles.

THE PLANT executive who takes time to note industrious endeavor among his employes, and who encourages initiative and constructive suggestions, does much to improve his plant and his men.

Production of Electricity for August

AVERAGE daily production of electricity as reported by the Department of the Interior, Geological Survey, for the month of August, 1923, was 150,200,000 kw.-hr. This output compared with previous months indicates that the "July slump" has passed and that production has returned to approximately that figure which was maintained during May and June of 1923. The curves given herewith show the total average daily output of electricity in kilowatt-hours by public utility



MILLIONS OF KILOWATT-HOURS PRODUCED BY PUBLIC UTILITIES FROM 1920 TO 1923

plants for the past four years. Curves are also given which show the proportion of production by fuel power and water power for the same period.

It is interesting to note that the production by water power is falling off due to the approach of the low water season. In July 36.6 per cent of the total production was generated by water power, whereas in August this proportion had fallen to 34.2 per cent. The deficit due to the water power plants and the increase in total load have been picked up by the fuel burning power plants.

During the month of August the public utilities used 3,196,950 short tons of coal, 1,283,584 bbl. of fuel oil and 3,380,720 thousands of cu. ft. of natural gas for a total production of 3,061,149 thousands of kilowatt-hours.

SPECIFIC HEAT of a substance is the number of B.t.u. required to raise the temperature of one pound of the substance one degree F. To be exact, the temperature range should be stated. The mean specific heat is the average of the specific heats for each degree within the range considered.

THE INQUIRING ENGINEER

The Inquiry

THERE SEEMS to be some question in the minds of many engineers as to the advisability of using grooves in bearings. It has been contended that where the bearing has been properly designed for safe unit pressure and where the correct lubricant is used, no special grooving is necessary. Are grooves in bearings always necessary or even desirable? If not, under what conditions should they be employed? When may they be omitted? What factors must be considered in a solution of the problem?

Replies

CLAUDE C. BROWN,
Los Angeles, Cal.

This idea of the necessity of cutting oil grooves in bearings has been handed down to us as a sort of maxim, with the result that the number of grooves is often large and their location wrong and carelessly made, so that instead of assisting in the lubrication of the bearing, they many times seriously handicap it by draining away the oil from the points where it is most needed.

Many methods of lubrication are now employed. For high speed rotative machinery such as steam turbines we have the pressure lubricating systems, where the oil is pumped through the bearings under pressure, being generally introduced at the bottom of the bearing where the maximum pressure exists. This system floods the bearing and no recourse to oil grooves is necessary. It embodies the elements of both flushing out and cooling the bearing, which are of the utmost importance in present day practice.

For general purposes such as the bearings of motors, centrifugal pumps, grinders and other machines we have the ring-oiled type of bearing, which picks up the oil from a reservoir below the bearing and delivers it at the top of the journal at the point of least pressure. From this point the oil is drawn into the bearing, spreading as it goes.

As the speed of a journal increases its center approaches that of the bearing, and finally assumes a position, for any given speed, whose eccentricity with the bearing depends upon the load carried. As the speed is increased within certain limits, the eccentricity is decreased. As the load is increased at a given speed, the eccentricity increases, the center of the journal proceeding along a line from the center of the bearing and inclined at about 18 deg. below the horizontal. As the load is increased to the maximum limit, the center of the journal proceeds along this line until a point is reached which is approximately one quarter of the clearance distance between the journal and the bearing diameters. At this point the rupture of the oil film occurs, lubrication fails and the bearing seizes. The position of the area of maximum pressure varies from the bottom of the bearing at rest, to a point about 45 deg. below the horizontal, in the direction of rotation, at maximum load. It is evident that any oil grooves within this area would serve only to drain away the oil under pressure.

The larger the unbroken area of the oil film, the greater will be the supporting capacity of the bearing. Every oil groove or other interruption in the continuity of the film reduces this supporting capacity. Improperly placed oil grooves not only decrease the available bearing area (many times to a dangerous degree), but they tend to destroy the oil film and drain away the oil from the points where it is most needed. This is especially true of grooves placed within the pressure area.

In the design and construction of bearings many things may be done to facilitate the proper lubrication of the bearings. In the first place proper clearance should be allowed between journal and bearing, so that an adequate thickness of oil film may be had over a finite range of eccentricity. This clearance may vary from 0.0002 in. to 0.0006 in., depending upon the purpose of the apparatus.

Edges of the bearing at the division points should be chamfered off in order to permit a supporting oil film to form, as an oil film forms most effectively upon a bearing surface whose advance edge is at right angles to the direction of motion. Also, sharp edges at the division point will wipe off of the oil film if too close fitting.

This chamfering off of the edges of the bearing will then do all that any system of oil grooves is supposed to do and yet embrace none of the faults of the latter. Many manufacturers are now limiting the cutting of oil grooves to possibly one groove along the top of the bearing parallel to the journal and the chamfering off of the bearing edges, having found that such practice gives better results than the former elaborate systems of grooves.

With the present highly perfected methods of producing high grade and dependable lubricants that can and are being used and re-used, and with present day apparatus of correct and carefully executed design,

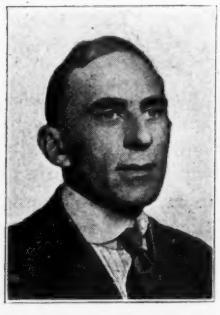
where the bearings have received their full share of attention, and where due consideration has been given to the subject of lubrication, any oil grooves cut in the bearings will be productive of more harm than good. This is especially true of high speed apparatus wherein the lubricating oil is pumped to the bearings under pressure, and performs the duties of flushing and cooling the bearings as well as lubricating them.

In small slow speed installations, the bearing surface is designed so liberally in the majority of cases, that the detrimental effects of the oil grooves cut in them, which are probably cut more out of force of habit than anything else, are not noticeable unless the cutting is overdone and the bearing surface area reduced to a dangerous degree. In this type of bearing the accumulation of heat is slower than is the case with heavier loaded bearings operating at high speeds and the danger of a bearing burning out is correspondingly more remote. Even here, however, a groove placed in the pressure area may so effectually drain the oil from the pressure area that seizure of the bearing will result.

C. G. Sprado, Gas and Oil Engine Dept.,
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Oil grooves should be used only to the extent of guiding oil into the bearing toward the pressure zone. They should always be short and never extend to outside of bearing, or closer than 30 deg. to line of highest pressure.

G. A. Luers, Consulting Mechanical Engineer,
Washington, D. C.



If, as frequently is found, the bottom of the bearing is grooved, especially with a lengthwise groove, the journal loses the support of the area which is occupied by the groove. Having cut away the metal at the place of contact, the unit pressure of the remaining area is increased and further, from the manner in which the journal turns in the bearing, the edge of the oil groove becomes a most undesirable wiper which scrapes off the oil film on the journal.

The experience of the writer has been that a high bearing pressure combined with an oil groove or grooves at the place of heaviest contact results in unsatisfactory lubrication.

The methods of lubrication which have given satisfaction have been with low bearing pressures, around 50 lb. for from 300 to 500 r.p.m., with the surface under the journal continuous and with the lubricant brought into the bearing at the open or unloaded section of the bearing or above the journal.

In revolving, the journal takes up the oil and carries an unbroken film under the loaded section of the journal. Another factor to consider is that of chamfering or beveling the edge of the bearing cap to prevent this edge acting to scrape away the film.

To insure the oil spreading on the journal surface, a single oil hole is not as assured a means as a channel or groove extending some length, only a fraction short of the length of the bearing. By making the channel long, a reservoir of some appreciable size, that will supply without doubt the necessary oil film, is provided. With a single oil hole, however, the oil is led to only a small part of the journal surface and lubrication is dependent upon the adherence of the oil to the journal and to pressure to film it out to cover the length of the journal.

While other refinements as circumferential grooves at the ends of the bearing to trap the oil from going out at the ends are used, they cannot well be supported by argument in an analysis of the conditions. The main consideration is to enter the oil where there is an absence of pressure, spread it over the journal by means of suitable oil leads and leave an unbroken oil film if possible under the journal where the load is taken up.

W. A. Kreider, Sales Representative,
Erie Ball Engine Co., Chicago, Ill.

It is the writer's opinion, based on experience, that main bearings should be grooved, and the grooves should be cut in such a way that there is a tendency to work the oil towards the middle of the bearing. I am well aware of the fact that many authorities will differ with me on this statement, but I base my opinion on actual experience where the bearings have to be run with close clearances.

R. A. Fiske,
Waukegan, Ill.

Correct selection of lubricating oils, proper maintenance and supervision of bearings will put at an end most of the controversy regarding the grooving of bearings. Too often a bearing is elaborately grooved with the expectation that lubrication troubles will disappear. In most cases as a matter of fact, the most simple grooving possible will prove effective.

Ordinarily a single longitudinal groove, extending to within a short distance of the bearing ends will prove all that is required. For large bearings this groove may be connected up with two openings through which oil may be fed. The edges of this groove must be well rounded, so that they will not tend to wipe the shaft.

Chamfering of the edges of split bearings will act as an oil reservoir and will aid in the uniform distribution of the lubricant. Grooves should not be cut through the area of greatest pressure as they will only make a bad condition worse for they lessen the effective bearing surface and so increase the unit pressure.

Practically, the oil groove can be used to an advantage provided that it is not overdone and that judgment is used in the other factors involved in bearing design and operation. This applies of course to such bearings as are adaptable to the use of the grooving method of oil feed and distribution.

It cannot be arbitrarily said that bearings should or should not be grooved. Judgment must always be used. Questions of temperature, size, speed, bearing pressure, oil pressure, viscosity and other properties of the lubricant must all be given due consideration before any definite design for any particular bearing is adopted.

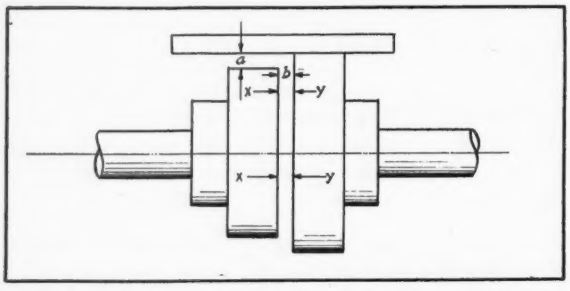
Foundations for Small Engines and Motors

PROPER SETTING IS THE FIRST STEP IN SECURING SATISFACTORY OPERATION OF SMALL DRIVING EQUIPMENT

IN THE installation of small engines and motors, the engineer is often confronted with the task of providing a suitable foundation. While this is usually a simple proposition, there are certain precautions to be observed.

Every engine should be set on a firm foundation, which in turn should rest on a solid substratum. The weight of this foundation should be at least equal to the weight of the engine or other apparatus resting upon it. For general practice, the weight should be somewhat greater, depending, of course, upon the character and location of the installation.

Where the ground is soft, the foundation should be flared a considerable amount, or the footing course increased in size to resist its tendency to settle. The top should extend at least 6 in. outside the outline of the base of the apparatus, and should be beveled on the edge to prevent chipping.



SHOWING METHOD OF ALINING COUPLINGS, THE HALVES OF WHICH ARE OF DIFFERENT DIAMETERS

Foundations of brick or stone are serviceable when brick work is close jointed and laid in good cement mortar and when stone work is of regular form so that the stone forms a good bond with the mortar. A concrete foundation, however, is to be recommended for all classes of work.

Where structural steel frames, of a size suitable to carry the weight and to withstand the vibration are present, it will be found convenient to bolt the engine directly to such steelwork.

LOCATING AND SETTING THE ANCHOR BOLTS

One of the most important things in the setting of any piece of machinery, is the proper setting of the anchor bolts. For doing this properly, it is necessary to make a template. Stock ⅞ in. thick or thicker may be used, keeping in mind that the more rigid the template is, the less will be the liability of the anchor bolts being disturbed when the concrete is poured.

On the template should first be laid out the center lines of the engine, one line corresponding to the center line of the cylinder, and one corresponding to the axis of the crank shaft. These dimensions may be taken direct from the blue prints which are furnished by the manufacturer of the engine. From the center lines, all anchor bolt holes should be laid out and the whole template should then be carefully checked to eliminate any errors.

In cases where the foundation is to extend any distance above the ground line, a wooden form will be necessary for filling in the concrete. This form should be set low enough to allow placing the template so that its bottom will be 1 in. below the bottom of the apparatus. After the wooden form has been placed in position, the template should be set in the exact position desired.

Anchor bolts should be surrounded by a pipe casing, preferably of thin sheet iron. The diameter of the case should be at least ½ in. larger than the anchor bolts and should be of proper length to allow for the thickness of the base of the apparatus and a full thread for the nut. Anchor bolts and casings are next set in position and should be secured in place by means of washers and nuts. The template should be thoroughly secured to prevent any removing and should be braced to prevent any sagging which may be due to the weight of the bolts.

Concrete is then poured into the form until it is level with the bottom of the template. It should be allowed to stand a week or 10 days, depending upon the size of the foundation before the apparatus is placed in position.

SETTING THE MACHINE ON THE FOUNDATION

After the template has been removed and the anchor bolts cleared, the engine is placed on the foundation, which should be carried over the anchor bolts on skids sufficiently high to prevent injuring the bolts. When in the correct position above the bolts, it is jacked up or lifted one side at a time, the blocking removed and the engine lowered onto the foundation. Care should be taken to see that all anchor bolts are clear of frame while engine is being lowered.

To assist in leveling and alining, steel plates at least 6 in. square and iron wedges 2 in. or more wide may be placed beneath the frame. In leveling, it is usually necessary on account of the weight of the apparatus to use more than three points of support. The size and outline of the base will usually indicate the necessary points of support.

ALINING

In cases where it is necessary to install the engine before other apparatus is finished, it can be alined as follows: From two points on the center line of the shaft to be driven, drop plumb lines to points on the level surface. A line connecting these two points will be parallel to the center line of the shaft. Upon leveling the engine and making its shaft at all points equal distance from this reference line, the engine will be parallel to the shaft to be driven. When the engine has a pulley or flywheel, a straightedge placed across the edge of the latter will give a line perpendicular to the center line of the crank shaft. A steel square can now be used to bring this straightedge at right angles to the reference line as determined above. This will make the desired center line parallel. When this method is used, it is, of course, first necessary to determine whether the edge of the pulley or flywheel used runs true.

When the shafting to be driven is already installed, to a piece of wood about 1 in. by 2 in. in cross section

and somewhat longer than the distance between the shafts, nail two short pieces whose edges are a distance apart equal to the desired distance between the shafts minus half the sum of their diameters. This will form a convenient inside caliper with which the shafts can be easily paralleled.

Special Cases

A—Belt-Driven High Pressure Blowers and Fans, etc.

It is assumed that the apparatus to be driven is properly installed and the line of pulleys approximately known from the layout of the foundation.

(a) When driving and driven pulleys are of the same width of face, a line drawn taut across two points as nearly diametrically opposite as possible on the edge of the driving pulley and extended to the driven pulley will furnish a guide.

When the engine is moved to its proper position, the line as indicated will touch the edge of each pulley at two points.

(b) Pulleys of different widths of face.

Two strips equal in thickness to one-half the difference of the widths should be placed across the edge of the narrower pulley. Using the side of the pulley so treated as "the working edge," proceed as in the case where both are of equal width.

Engines Direct Coupled to Generators

B—When the engine is direct connected to a generator the armature is often carried on a shaft, joined to the main engine shaft by means of a male and female coupling, the outer end being carried in a self-alining bearing. In such cases after the anchor bolts have been tightened securely, the coupling bolts should be loosened slightly. If the generator bearing is too high, the coupling will open on the bottom, and if too low, the coupling will be at the top. A set of thickness gages graduated from 0.001 in. in thickness up, will be useful in determining this.

Too much emphasis cannot be laid upon the importance of having generator bearings in perfect alinement for successful operation.

Apparatus Driven Through Flexible Coupling Containing Rubber Bushings

C—Flexible couplings, the halves of which are of different diameters and which may be rotated independently of each other, can be brought into alinement whether their faces are "true" or not by the following method:

Consider two such couplings A and B, Fig. 1, which are not of the same diameter and whose respective faces X X and Y Y are not at right angles to the axis of the shaft.

They should be forced apart until all end movement is taken up against a thrust bearing. (If there is none, one should be provided.) With the coupling in position indicated, a straightedge is placed across the face of the larger, and the distance "a" between the straightedge and the face of the smaller carefully measured by a set of thickness gages. Also the distance "b" between the inside faces at a point adjacent to the first measurement. Both halves of the coupling are rotated through 90 deg. in the same direction, and the same measurement again taken. Likewise at the bottom 180 deg. from the starting points, and again at the next quarter, or 270 deg. from the starting point. If the measurements for the two distances are respectively equal at all points, then the axes of the shafts are in the same straight line. If the couplings are known to "run true" and are of the same diameter, a straightedge across the outside faces and the distance between the halves at four points 90 deg. apart will give a true test of the alinement.

Grouting

After apparatus has been properly leveled, alined, and anchor bolts securely fastened, the grouting can be run into a form, placed around the base of the apparatus. It should be of suitable depth to insure proper bedding in. For grouting or bedding in, the following mixture will give satisfactory results:

1 part Portland cement
2 parts sharp sand.

The dry ingredients should be turned over at least eight times and after water is added the mixture should be turned over at least five times more. An excess of water, however, is to be avoided as it tends to allow the parallel parts to settle at the bottom before the mixture hardens. The grouting should be mixed so that it will flow freely. The top of the foundation should be thoroughly wet before grouting in order to insure a good bond with the concrete which has already hardened. It is not necessary removing the plates and wedges, as these are securely imbedded in the concrete.

The foregoing article is based on information contained in the Engine Instruction Book of the B. F. Sturtevant Co., of Hyde Park, Boston, Mass., to whom credit is hereby extended.

A determination of the heat reactions in the distillation of coal has been made by J. D. Davis, chemist, Department of the Interior, attached to the Pittsburgh Experiment Station of the Bureau of Mines. Distillation tests were run on various kinds of coal, wood and peat, at various temperatures. Results showed that there were two critical temperatures approximately 475 deg. and 650 deg. C. At these points is the greatest reaction speed in the primary decomposition of coal complexes. In hydrogen below 450 deg. C. in temperature reactions are mainly exothermic, whereas in inert atmospheres (N_2) they are endothermic. At 475 deg. C. it appears that the point of greatest reaction speed in the decomposition of coal is reached. Wood and peat show the same general characteristics as bituminous coal, except in this case there seems to be a more pronounced critical point of 650 deg. C.

In conjunction with the committee on coal and coke of the American Society for Testing Materials, methods for making size tests of powdered coal both by hand and machine sieving, have been formulated by W. A. Selvig, assistant analytical chemist, attached to the Pittsburgh Experiment Station of the Bureau of Mines, Department of the Interior, and sent to various co-operating laboratories for trial and criticism. This work will be continued with a view to formulating a satisfactory standard for making fineness tests of powdered coal.

Oil Used to Heat 9-Story Garage

NEW DON LEE GARAGE IN SAN FRANCISCO CONTAINS INTERESTING MECHANICAL FEATURES. BY C. W. GEIGER

ONE OF THE finest buildings of its kind in the world has recently been completed in San Francisco. This is the Don Lee Garage, a nine-story structure which is said to be the most modern building ever planned throughout, for the one purpose of serving the motoring public.

It is evident that the mechanical features of a building of this type are of interest to engineers, and it is

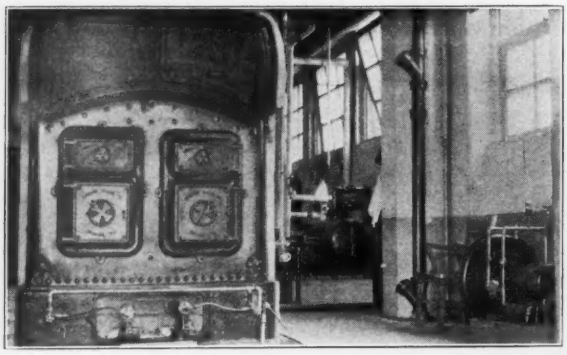


FIG. 1. DON LEE BOILER ROOM. FESS OIL PUMP SHOWN AT RIGHT. THE 2-IN. LINE BACK OF THE CHAIR CARRIES WASTE OIL FROM TANKS ON 6TH FLOOR TO FUEL OIL STORAGE TANK

the author's intention in this article to describe briefly some of these features, with particular reference to the heating plant.

Oil is used for fuel, a system known as the Fess Oil Burning System being installed. Oil is drawn from a 1360-gal. fuel oil tank under the sidewalk by means of a centrifugal oil pump direct connected to a 3-hp. electric motor operating at 3500 r.p.m., and is delivered to the oil burners at a pressure of 30 lb. The main boiler is a Kewanee locomotive type fire box, return tubular unit generating steam at 55 lb. pressure.

Steam is carried to the eighth floor at a pressure of 55 lb. and is there reduced to 25 lb. for supplying heated air to three motor driven blowers for the dry room of the paint shop. There are 260 ft. of 2-in. radiators for heating the air for the blowers. Steam is also used in a system of coils for heating liquid to the boiling point, which is used for removing paint from cars. All condensation returns to the boiler room. A single cylinder American pump delivers the return water back into the boiler.

Hot water for the entire building is furnished by a Kewanee refuse burner operated in connection with a 500-gal. hot water tank. Although the incinerator is equipped with an oil burner since the plant has been started, no fuel has been required other than the refuse which accumulates on the various floors of the building. Two janitors are kept busy daily, picking up this refuse which is then transported in special carts to openings in chutes leading to a bin in the basement just in front of the refuse burner. The water tank is also connected to the main boiler so that steam from the latter could be used for heating the water if necessary. It is connected directly with the city pressure and is under a pressure of 90 lb. per sq. in.

In the boiler room there are also two Rix air compressors, each being belt driven by an individual electric motor. One compressor is kept in operation and the other is held in reserve, as a guarantee that there will always be a proper supply of compressed air. The compressed air is supplied to all floors of the building by 2-in. air pipes which are run vertical.

For the purpose of conserving oil, gasoline and distillate of which a considerable amount is handled, the superintendent of the building has introduced a novel system. Extensive machine shop and repair departments are located on the seventh floor. On this floor there has been provided a 60-gal. steel tank, into which all engine crank case oil, all gasoline and distillate used in cleaning parts, and all lubricating oil are emptied. In the top of the tank is a series of strainers through

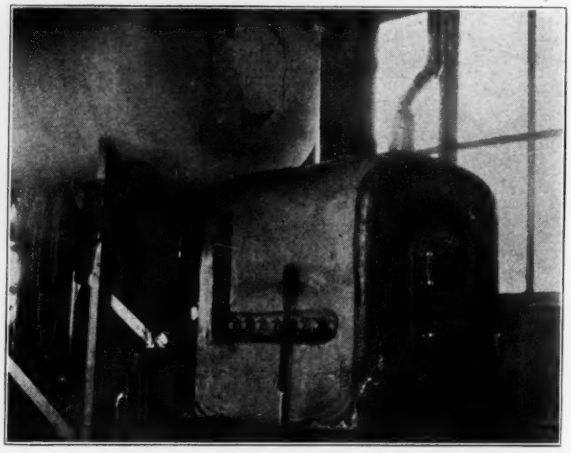


FIG. 2. REFUSE BURNER HEATS WATER IN OVERHEAD TANK

which the various oil passes. In the bottom of the tank there is a 2-in. pipe which leads to the 35-bbl. fuel oil storage tank located under the boiler room. This oil is mixed with the regular fuel oil in the storage tank and used in firing the boiler, effecting a saving of over $400 last year.

On the seventh floor is a special steel drum carried on a small truck which is used in picking up the oils throughout the shop. The oil is emptied from this drum into the top of the 60-gal. tank, the rags, bolts, nuts, etc., being caught by a coarse screen. The oil then passes down through a 6-in. excelsior strainer. In the bottom of the tank there is also a valve and pipe for draining the water off. Six inches from the bottom of the tank is a drain for drawing off the oil. A gage glass shows the height of the oil and water in the bottom of the tank. Each morning the water is drawn off and the good oil is drawn to the oil storage tank under the boiler room.

ON ACCOUNT of the fine tips used with mechanical burners, it is necessary to provide better straining facilities than with steam atomizing burners. No difficulty attributable to the high pressure necessary for mechanical burners has been experienced with types of strainers now in use.

Pipe Wall Thickness Chart

By Dwight Gerber

IN THE ACCOMPANYING illustration is shown a chart which is intended to facilitate the work of an engineer in the matter of writing piping specifications or in making piping layouts.

It is based on a tabulated statement issued by the Crane Laboratories and published in the 1923 report of

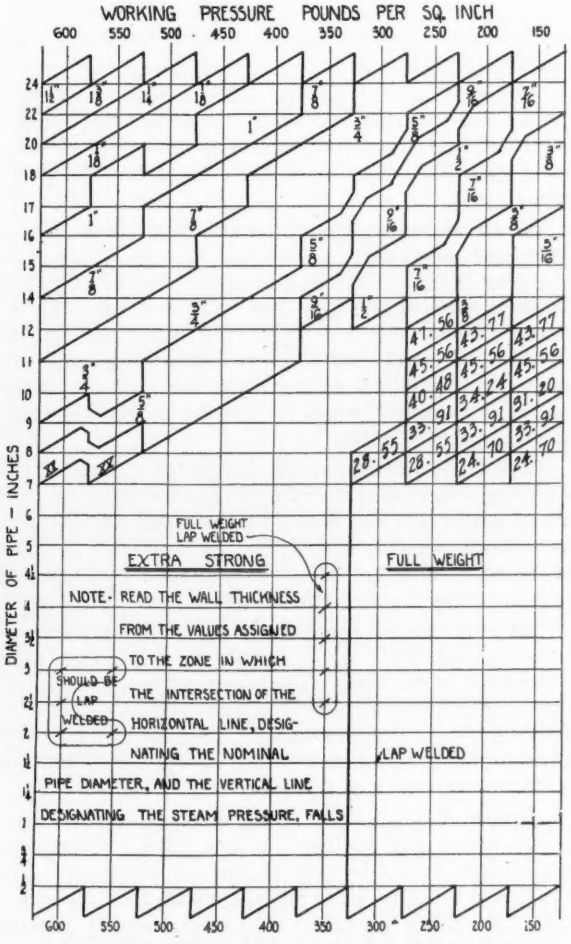

WORKING PRESSURE POUNDS PER SQ. INCH
600 550 500 450 400 350 300 250 200 150
DIAMETER OF PIPE — INCHES
FULL WEIGHT LAP WELDED
EXTRA STRONG
FULL WEIGHT
NOTE- READ THE WALL THICKNESS FROM THE VALUES ASSIGNED TO THE ZONE IN WHICH THE INTERSECTION OF THE HORIZONTAL LINE, DESIGNATING THE NOMINAL PIPE DIAMETER, AND THE VERTICAL LINE DESIGNATING THE STEAM PRESSURE, FALLS
SHOULD BE LAP WELDED
LAP WELDED

CHART FOR DETERMINING PIPE WALL THICKNESS

the Prime Movers Committee of the National Electric Light Association. The reading is performed in accordance with the data on the chart.

Thus, a 12-in. diameter steam line carrying 450-lb. pressure should be 5/8 in. thick.

These values of wall thickness may be used for lines carrying a temperature of 700 deg. F. Higher temperatures than that cause the elastic limit of all wrought steel pipe material to fall rapidly. This chart in abbreviated form is contained in catalog No. 6 soon to be issued by the National Valve & Mfg. Co., of Pittsburgh, Pa.

Don't expect your pump to operate satisfactorily if the suction is not protected by means of a mesh or strainer to keep foreign matter from entering and blocking up the ports of the runner.

Are You One of the Ninety-Five Million?

THERE ARE approximately ninety-five million people in the United States who are *not* members of the American Red Cross. All of them ought to be members. Most of them probably are willing to be. They think the Red Cross work is a good work; they believe in it heartily. But when it comes to joining —well, perhaps nobody happens to ask them, or perhaps they forget about it, or perhaps they don't happen to have a dollar handy.

Now, the Red Cross Roll Call will be held this year from Armistice Day to Thanksgiving, Nov. 11 to 29. The Roll Call isn't a campaign or a drive; it is simply the time set for the renewal of memberships. The Red Cross relies on those dollar memberships to carry on its work. Half of your dollar last year—if you are not one of the ninety-five million mentioned above—went to your local chapter for local work; the other half went to National Headquarters in Washington for national work—which in the last analysis is local work too.

You probably know pretty well what the Red Cross is doing. You know of its campaign against preventable disease, which it is carrying on through the development of public health nursing, through the Nutrition Service, through its classes in Home Hygiene and Care of the Sick. You know of the Disaster Relief work, of the classes in First Aid, of the Life-Saving Corps which it has organized. You know that it is helping the disabled veteran of the World War, that it is still with the Army and Navy. You know that it is chartered by Congress for these things.

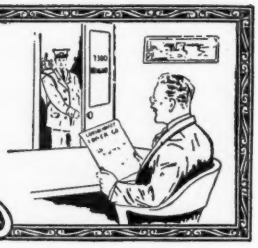
Knowing these things, don't you think it is up to you to join? The Red Cross, remember, is *your* Red Cross. It needs your support. You are not giving that dollar to the Red Cross, either—you are giving it to humanity, and therefore to yourself, as a fraction of humanity.

That, you may think, is a little far fetched. But is it? If Red Cross health work in your community is cutting down the death rate, cutting down the accident rate, teaching people generally to guard themselves intelligently against disease—isn't that cutting down your chances of dying suddenly from accident, or slowly from some disease contracted through the ignorance or carelessness of a neighbor? You are not isolated from the rest of humanity. You are meeting other men, your children are playing with other men's children, every day; and if one of those men and his children are infected with, say, tuberculosis, he is a direct menace to your health.

Don't be one of the ninety-five million. Do your share this November to help on the work of the Red Cross. Pay your dollar and add your name to the roster of those who believe that the efforts of the Red Cross are making for a healthier and happier America.

When a fresh charge of bituminous coal is first spread over a hot fuel bed the coal is rapidly heated and a part of the combustible is distilled off immediately. This is a distillation process, which tends to hold the temperature down. The temperature is raised when the distilled volatile combustible passes into the combustion space, where it is completely burned.

LETTERS DIRECT FROM THE PLANT



Gaskets and Packing and How to Use Them

In the Aug. 15 issue of Power Plant Engineering, C. A. Underwood and J. R. Darnell presented an extended article on the subject of Gaskets and Packing. I have no doubt but that Messrs. Underwood and Darnell were sincere in their efforts to write an authoritative article on the subject of packing, but I cannot say that I am at all in agreement with the recommendations they put forth in this article and with conclusions they arrive at.

What they have recommended for ammonia can be used only on Wolfe machines. Metallic packing can be used on all rods in the plant, and is not confined to reciprocating units. The bearing segments are not "in almost all cases" made of soft grey iron. The nature of the bearing metal has nothing to do with holding condensation. Metallic packing "specially designed for piston rods" is not always fitted inside the split case. Sometimes the case is solid, and sometimes, as with U. S., and Paxton, and Cooke, there is no case at all. The fitting of the packing in the case of the rod has nothing to do with "perfect freedom of lateral movement." To recommend that a plant make its own packing is absurd. Figure 3, which incidentally is not an inside split case but a bolted-on stuffing-box, will not meet all requirements of ordinary operation.

As I stated in the first part of this letter, I haven't the slightest doubt that Messrs. Darnell and Underwood were really in earnest in their efforts to write a good article on "Packing"; but they certainly did make a mistake when they attempted to generalize what was evidently a limited experience. A. C. Judd.

New York, N. Y.

Your recent letter quoting criticisms of the article by Mr. Underwood and myself on Gaskets and Packing was received with considerable interest. Constructive, logical criticism is always invited and we are always glad to exchange ideas and opinions with other engineers. Our critic, however, has made some statements which, to say the least, are unreasonable.

In spite of the fact that the ammonia packing we have recommended is also recommended by all the leading manufacturers of packing, our critic flatly states that such packing can be used only on a Wolfe machine. Without discussing the packing requirements of the Wolfe machine, we wish to state, again, that our recommendations are for such machines as the Vogt, Vilter, Carbondale and any other type of machine which has piston rods.

We do not make the statement that metallic packing is confined to reciprocating units, but we do say that metallic packing is to be especially recommended for all large reciprocating units.

The operator who uses metallic packing on all rods in the plant invites trouble. We know that unfortunately there are on the market a number of cure-all packings. This seems especially true of metallic packings.

In our article we state, "In almost all cases it is to be recommended that the bearing segments be made of soft grey iron." We *recommend* that the bearing segments be made of soft grey iron. We do *not* say that in almost all cases they *are* made of soft grey iron, but we do take the stand that soft grey iron made into segments and installed as described under the heading "metallic packing" is best for long service on large rods of reciprocating units.

We do *not* state that the nature of the metal has anything whatever to do with holding condensation, but we *do* assert that the nature of the metal has much to do with the amount of friction. Where there is much moisture, a hard bronze is recommended by engineers who have experience with packing.

Metallic packing especially designed for piston rods is not always fitted inside a split case, but it is most convenient in this form. The reason why we recommend the segmental packing is that such packing does give freedom for lateral movement. Packing not properly fitted is liable to cause difficulty by pinching the rod and causing excessive friction.

Proper fitting is one of the most important items in the life of any packing. It is a job for a mechanic and should never be left to careless workmen. The writers personally know of one plant that has made its own metallic packing. Of course, metallic packing cannot be made without a lathe. We know of many plants that make their own piston rings; making metallic packing is not a more difficult job. Just have your case cast and machined, then have your machinist make a micrometer measurement of the rod. No machinist will say that he cannot do the job.

We do not claim that the packing pictured in Fig. 3 of our article and described under the heading of metallic packing is a cure-all packing, but we have found it most efficient for large reciprocating steam units.

In our article we have not attempted to eulogize any special brand of packing. We have not felt it our duty to recommend that any certain brand be used. We have tried to deal strictly in generalities, but we wish to state emphatically that the cheapest is not always the best and that there is no packing fit for all kinds of service.

As previously stated, we invite reasonable criticism and shall be pleased if you will publish this letter, so

that others may enter into the discussion, if they care to. The subject of Gaskets and Packing is one of which too much cannot be written.

East Chicago, Ind. JOSEPH R. DARNELL.

I WAS glad to receive Mr. Darnell's reply to any criticism of the article Gaskets and Packing which appeared in the Aug. 15 issue, as it gives me the opportunity to make some additional comments.

As I stated before, the combination of duck and pure gum, which Messrs. Underwood and Darnell recommend, can be used only on Wolfe machines, on which the temperature is relatively low. The F. W. Wolfe Co. used a pure gum for years in combination with a thin metal packing ring and it worked very satisfactorily, except in the instances where hot gases came back on the machines. To attempt to use such a packing on a Vogt, or Vilter, or Carbondale would result in failure because the gum rubber cannot withstand the high temperatures of the gases which frequently come back on these machines. "The leading manufacturers of packing" may recommend that the duck and rubber combination be used, but the ice machine manufacturers do not use it.

Mr. Darnell may not have made the statement that metallic packing is confined to reciprocating units, but he does say in the third paragraph of his article on page 816 of the Aug. 15 issue, "It is to be especially recommended for all reciprocating machines," and in the same column, paragraph 7, he states, "Carbon packing may be contrasted with metallic, in that the former is used on revolving shafts, while the latter is to be used on those that slide." I think that the casual reader would gather from these two remarks that the use of metallic packing is confined to reciprocating units.

With reference to Mr. Darnell's statement that "The operator who uses metallic packing on all rods in the plant invites trouble," I again wish to state that I do not agree with him. The operator who uses metallic packing on all rods invites not trouble, but *freedom* from trouble; for he has nothing but trouble when he uses a soft packing. Mr. Darnell implies in his second sentence of the fourth paragraph of his letter, that I am trying to say that there is one type of metallic packing which is a universal cure-all. I do not so state, because no one type of metallic packing can be used on all the stuffing-boxes of all the units in one plant; but there are different types of metallic packing, one or more of which can be used to pack every stuffing-box on every unit in the plant, including oil, ammonia, carbon-dioxide, brine, water, steam, air, and all the various acids and alkalies that are handled in a chemical plant.

Mr. Darnell is in error in recommending that "in almost all cases the bearing segments be made of soft grey iron." The material of the bearing segment depends entirely upon the service on which the packing is operated. "For large rods of reciprocating units" a soft grey iron is not the best bearing metal for segments. In his letter, Mr. Darnell says: "We do not state that the nature of the metal has anything whatever to do with holding condensation," yet in the fourth paragraph of the first column, page 816 of the Aug. 15 issue, it is stated, "If there is much condensation, it is advisable to use bearing rings of a softer metal."

Whether metallic packing is to be fitted in an inside split case or an outside case, or half in or half out, or without the case, depends entirely upon the dimensions of the rod, the stuffing-box, and the clearance. It is not a question of convenience, but of the design of the equipment which affects in turn the design of the metallic packing which is applied to that equipment. Practically all metal packings are segmental, but the fact that they may be segmental will not necessarily "give freedom for lateral movement," because freedom for lateral movement depends entirely upon the design of the packing. Some, for example, permit lateral movement only, while others permit both lateral and rocking movements. The fact that the packing does not fit has nothing whatever to do with "pinching the rod and causing excessive friction." Packing which doesn't fit will leak. Excessive friction is caused either by lack of the proper lubrication or use of the wrong composition of metal.

It is, of course, essential that any metal packing should fit, but the fit of the packing has nothing to do with the life. The fit affects only the matter of leakage. A good fitting packing prevents leakage. A bad fitting packing causes leakage. The life of the packing depends on material and the construction. This subject is most certainly a job for an experienced mechanic, working under the direction of a man who has studied metallic packing for the better part of his machine shop experience. Many concerns do make their own piston rings. They think they are saving money but if they will buy their piston rings from concerns who have put their life work into piston rings, they will undoubtedly get better service. Undoubtedly any machinist can make the ordinary snap piston ring, but there are better piston rings on the market. I don't doubt that any machine shop can turn out a set of Katzenstein packing, because this is the most elemental form of packing still being used. But real floating packings are a different proposition.

We don't say that Mr. Darnell said that Fig. 3 was a cure-all packing; but we did say and do say again that this packing will not "meet all requirements of ordinary operation," because there are many cases where this type of packing cannot be used and should not be used. On this type of packing, there is not entire freedom of rod movement, because this particular design of packing takes care of lateral movement only and does not provide against the possible rocking movement of the rod.

Nor have we attempted to eulogize any special brand. We were discussing the general subject of metallic packing, as applied to all stuffing-boxes in all units of equipment in any plant. I have not at any time talked prices because the fitting out of a particular plant with metal packing can not be done on a price basis, but only by an experienced engineer who knows not only operating conditions but the types of metallic packing which would best meet his operating conditions.

A. C. JUDD.

Loose Set Screws

KEYS HELD in place by set screws will sometimes loosen up while the machine is in operation. To have such a key tighten up under the same condition is somewhat out of the usual run of things. Such a case

recently came to my notice on one of the connecting rods of a high duty pumping engine. The key persisted in loosening up, so one day an assistant, finding it in this condition, drove the key home to its limit, then backed it up a bit and tightened the screws.

For several days the bearing gave no trouble. Then it began to heat up. The usual remedies were applied to lower the temperature without shutting down, but they failed. The machine was shut down, and it was found that the set screws had again loosened and the key had worked down and tightened the box enough to cause the heating. The conclusion arrived at was that the driving of the key to its limit was the direct cause for its working tight instead of loose as formerly when the set screws loosened.

Numerous cases have developed where defective set screws were the cause of serious trouble. This is such a simple defect that writers appear to have overlooked warning about it, or they have touched upon the matter so lightly that the reader with not much practical experience is liable to miss its importance. Flywheels have loosened up and other serious conditions have been caused by it. All set screws should have perfect threads and be a snug fit in the threaded holes. When set screw holes have had the threads injured, the usual procedure is to re-tap and use the old set-screw. This is wrong, new properly fitting screws should be used. The next time you find a loose set screw do not tighten it up and let it go at that. Examine both the screw and the socket threads and note if the fit is right.

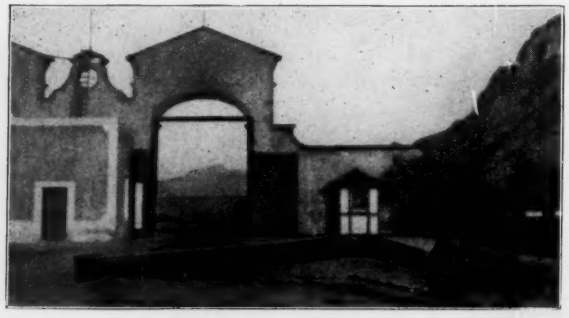
In my experience as repair man, I have often found that some careless worker has removed the hard set screw for some reason or other and replaced it with a soft iron screw. Set screws should have a snug, perfect thread fit, but they should not be tight.

Toronto, Can. JAMES E. NOBLE.

Result of Water In the Cylinder

MANY TIMES I have seen descriptions and pictures of wrecks of various character which supplied valuable hints as to what not to do.

Water in the low pressure cylinder of a 16 by 32 by 36-in. cross compound engine caused that engine to be



BUCKLED CONNECTING ROD CAUSED BY WATER IN CYLINDER

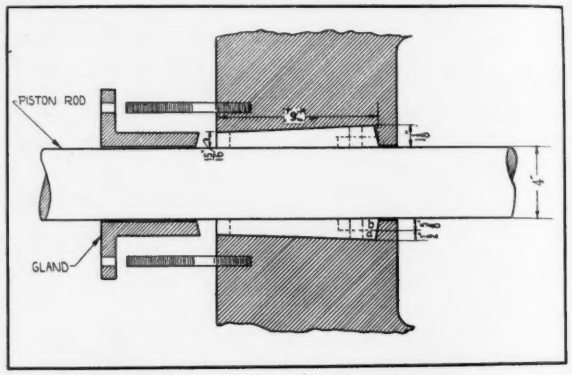
wrecked a short time ago. The accompanying photograph shows what happened to the connecting rod.

The engine in question was operating with a jet condenser independent of the other units and had been running in parallel with a 600-kw. unit during the day run. The engineer in charge of the shift, after cutting the generator off the line, closed the throttle valve, then stepped over and stopped the condenser pump while the engine was still running at about half speed with a vacuum on the low-pressure cylinder. Water rose in the condenser and immediately back up into the cylinder. Under this strain, both the piston and connecting rods buckled. The piston rod was straightened and the connecting rod renewed in our own shops without much delay and now the engine is running in perfect condition. The wonder of it is that the damage was not more serious.

Mapimi, Dgo, Mexico. E. H. BEAVERS.

Packing a Conical Stuffing-Box

CALLED UPON, not long ago, to start up an old engine which had been down for some time, I went to the place at once to look it over, and as the company was in a hurry for it I went to work with a determination to get it running in short order.



SECTION OF CONICAL STUFFING-BOX

Everything had been left in good shape when it had been shut down, and I was making rapid progress toward getting her ready until I came to examine the piston rod stuffing-box. It had been cleaned out, presumably when the engine had been shut down, but it was different from any that I had ever seen. The stuffing-box was 9 in. deep, and at its throat calipered just 15/16 in. between the wall and the rod. At the base or bottom it calipered 1⅛ in. How to pack this rod and do a satisfactory job of it was a puzzle to me, for when a ring of 15/16 in. packing was shoved to the bottom of the box it was lost. To pack this rod with 15/16-in. packing (and that was as large as you could get in) would require considerable pressure upon the gland, as the packing would have to be crushed until it filled the back end of the box, solid, from the wall of the box to the rod, and this would destroy the life of the packing. The accompanying sketch illustrates the cone-shaped stuffing-box.

To pack the box, I first cut a ring of ½-in. packing to a length such as to make it fit the outer wall of the box, away from the rod, as shown at a. Then I cut a ring of ⅝-in. packing, and fitted it inside of ring, a, as shown at b. Thus, rings a and b equaled one complete ring, 1⅛ in. thick, that filled the bottom of the box perfectly. With one ring in place, I proceeded to fill the box in the same manner that I had applied the first two rings (one outside the other), gradually decreasing in size as I neared the throat. For the last ring I used 15/16-in. stock which was just the proper

size. I then screwed up the gland pretty tight, released it, and then screwed it up finger tight only.

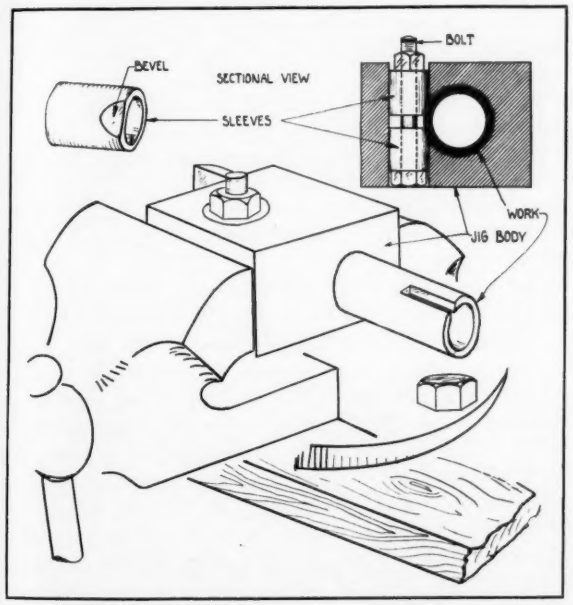
This job is still in service today, but it is needless to say that at the first opportunity the stuffing-box should be rebored to a cylindrical form and a liner inserted, thus cutting down the size of the packing required to about ⅝ or ¾ in. This would not only shorten the time required to pack it, but it would require less packing and would eliminate the necessity of carrying several different sizes of packing, which were required to pack it as I packed it in this emergency.

W. L. S.

Special Clamp Jig for Bushing Work

THIN SECTIONS of pipe, tubing, bushings and similar parts, when caught between vise jaws, change their shape or collapse. Semi-circular blocks of wood or brass are sometimes used in the vise to hold these cylindrical shapes while reaming, cutting oil grooves, keyseats or tapping; however, these means are not always dependable or satisfactory. In the accompanying sketch, a special clamp jig is shown which will not cost an appreciable amount more than the split semi-circular clamps, and serves the purpose of holding the circular parts more solidly and to better advantage than the other means.

As shown in the sketch, a cast-iron or other metal block, is drilled out to a size slightly exceeding the work.



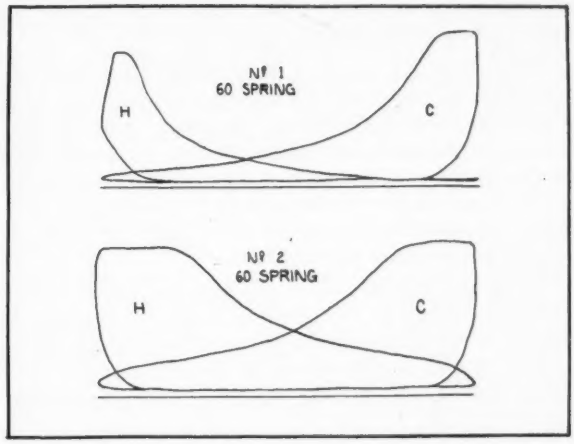
SPECIAL CLAMP JIG IS A SIMPLE BUT DEPENDABLE FIXTURE FOR HOLDING CYLINDRICAL WORK FOR REAMING, CUTTING OIL GROOVES, KEYSEATING, ETC.

At right angles to this opening, another hole is drilled. A long bolt with two beveled sleeves is the clamp. With a space separating the sleeves, the bolt is used to draw them together and thus gripping the bushing or tubing between them. With several blocks in which holes of usual diameters have been bored, these sleeves and clamp bolt can be used to hold corresponding sizes of work.

Washington, D. C. G. A. LUERS.

Tuning Up Corliss Engines

WHEN A new bracket and valve stem were installed recently on our double eccentric Corliss type engine, it was necessary to reset the valve gear. When the replacements had been made and before any adjustments had been attempted, the indicator card No. 1 was taken. Obviously admission was late on the head end. The engine was then turned over slowly and the travel of the steam wristplate noted. It was found that the travel was unequal, that the plate overtraveled on the head end; accordingly, the steam eccentric rod was shortened slightly which helped greatly the head end admission.



INDICATOR CARDS FROM A CORLISS BEFORE AND AFTER VALVE GEAR ADJUSTMENTS WERE MADE

A small adjustment was made on the steam valve rods and both the exhaust valve rods were shortened to reduce the amount of compression. The cutoff was equalized by altering the governor rods and card No. 2 was taken. Cards were taken, of course, while these adjustments were being made so that the effect of each step could be observed.

TOM JONES.

A Soldering Kink

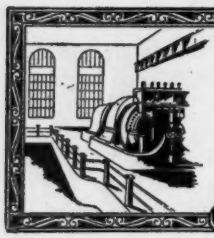
MANY TIMES an engineer wants to do some soldering, and is out of gasoline, or his torch is out of order, or he may need to do the soldering in some place where it is not safe to take the open flame of a torch.

I successfully overcame all of these handicaps when I melted lead in a plumber's lead pot, and set the pot in a tin pail to protect the lead from the cold air, carried this up five flights of stairs, and soldered three joints successfully. I completed my soldering job without the aid of a torch.

The melting temperature of lead is about 600 deg. F., and of solder about 400 deg. F., allowing a splendid working range.

When a soldered joint needs to be melted it can be done by scraping a bright spot on the joint, and applying mercury. The more you apply the faster it works. It does not affect anything but the joint. The mercury amalgamates with the lead in the solder and carries it away. These methods are safe and should be of value to any mechanic.

Winnipeg, Man. C. RYE.



PROBLEMS IN OPERATING POWER EQUIPMENT

Live Steam Cools Hot Turbine

SOME TIME ago, the writer in visiting a new generating station in Tacoma, Wash., came across an unusual operating condition which may be of interest to other readers of this publication.

This plant had installed in it two turbo generators, one a 6000-kw. unit and the other a 3000-kw. unit, both of General Electric Co. make. It seems, however, that during the summer months the demand for power does not exceed the normal supply of their hydroelectric units, so the large steam unit is used as a synchronous condenser to maintain the power factor as near unity as possible at the water power plants.

When the unit is used in this manner, the operation of the steam end is as follows: After the machine is brought to speed and synchronized on the line, the throttle is shut and further steam is obtained from a small 1½-in. line tapped into the admission valve chest opposite the throttle.

There are two reasons for doing this: First, it is necessary to keep a certain amount of return going through the turbine in order to keep the low pressure end cool and the small line offers a handy means of regulation.

Second, owing to the small steam consumption in the summer, they found it unprofitable to operate their own boiler room, so instead they have a contract to purchase enough for the auxiliaries and the above purpose from a steam heating establishment next door. The small line in this case offers a more accurate means of checking the amount of steam used, for the large flow meter on the main steam line barely registers for such small quantities.

My purpose in visiting this plant was mainly because of my interest in wood burning; in looking for one subject of interest, one often finds another. In this case, it was the supplying of steam to the turbine to keep it cool. Now, I must confess that I need considerable enlightenment on the subject of turbine heating when there is no steam passing through and the generator is operating as a motor; however, I should like to know just what the reason is for the turbine heating at all? That is, of course, to any extent. Still another phenomenon that is not quite clear, is that during the noon day it requires a considerable lot of steam to keep the turbine cool while at night it needed little in comparison.

As near as I could learn, conditions apparently were the same both on the steam and electrical ends of the unit in the middle of the day and at night. Engine room temperature was quite a bit cooler at night, but I cannot understand how that could make any appreciable difference. Perhaps someone else can shed some light on this subject.

JOHN U. MORRIS.

Would an Economizer Be Practical?

I WOULD like to install some 2-in pipe in our breeching to heat the feed water—build an economizer, in other words. We burn natural gas and there is no soot. We boil our feed water before it goes to the boiler so that we get a very small amount of scale. The feed water temperature is 194 deg. F., and the flue gases vary between 500 and 600 deg. F. To what temperature would it be practical to heat the water and how much pipe would be required? Our evaporation amounts to about 1000 gal. per hr.

A. In considering the question as to whether or not the installation of an economizer would be practical, it must be borne in mind that the placing of such an obstruction in the breeching materially increases the resistance to the flow of gases through the setting and a much stronger draft will be required. On top of this, the temperature of the flue gases is decreased, resulting in a loss of draft. For this reason, unless it is feasible to increase materially the capacity of your stack or to install an induced draft fan, it would probably be impractical to make use of an economizer.

Unless the boiler is operated at a fairly high rating, which necessitates high flue gas temperatures, the gain in efficiency obtainable by the use of an economizer may be negligible. Economizers result in small gain and sometimes even a loss in over-all efficiency when installed in connection with a feeble chimney draft and underloaded boilers.

One advantage of an economizer installation is the decreased wear and tear on the boiler which is obtained by reason of the high temperature of the feed water. It also provides a large storage for hot water to meet sudden steam demands. The economy of an economizer increases as the initial flue gas temperature increases and as the initial feed water drops. Inasmuch as your feed water temperature is fairly high and your flue gas temperature not excessive, it may be that an economizer installation would not prove economical in your case. There are given below, however, some figures on economizer design, making assumptions as to conditions wherever necessary.

It may be assumed first that the flue gas temperature is 550 deg. and that the quantity amounts to 25 lb. per lb. of coal burned. If you are able to evaporate 8 lb. of water per lb. of coal, then if you evaporate 1000 gal. or 8330 lb. of water per hr. you will burn $8330 \div 8 =$ 1040 lb. of coal per hr., and there will be formed $1040 \times 25 = 26{,}000$ lb. of flue gas per hr. It will be assumed further that it is desirable to raise the feed water temperature 100 deg. or from 194 to 294 deg. F.

As you evaporate 8330 lb. of water per hr., the heat added to the make-up would be $8330 \times 100 = 833{,}000$ B.t.u. per hr. To supply this heat the 26,000 lb. of flue

gas having a specific heat of 0.25 will have to suffer a decrease in temperature equal to $833{,}000 \div 26{,}000 \div 0.25 = 127$ deg. F. It will be seen, then, that the mean temperature of the flue gas is 486 deg. and that of the feed water 244 deg., giving an arithmetical mean temperature difference between the two of 242 deg. For this temperature difference and for an assumed velocity of flue gases through the economizer of 1000 ft. per min., the coefficiant of heat transfer expressed as B.t.u. per deg. difference in temperature per square foot of heating surface per hour may be assumed as 3.5. The extent of heating surface then may be found from the equation:

$$S = -[W \times Cp \times G] \div [F(1 - CpG)] \times \text{Log}_e [T_2 - t_1] \div [CpG(T_2 - T_1) + (T_1 - t_1)]$$

Where S is the total heating surface in sq. ft., W is the flow of water in lb per hour, T_1, the incoming gas temperature, T_2, the outgoing gas temperature, t_1, the incoming water temperature, Cp, the specific heat of the flue gases, G, the gas flow in lb. of gas per lb. of water, and F, the rate of heat transfer.

Substituting the known values in this equation, we have:

$$S = -(8330 \times 0.25 \times 26{,}000 \div 8330) \div [3.5(1 - 0.25 \times 26{,}000 \div 8330)] \times \text{Log}_e [423 - 194] \div [.25 \times 26{,}000 \div 8330(423 - 550) + (550 - 194)]$$

which may be reduced to:

$S = -9850 \text{ Log}_e .89 = -9850 \times -.1165 = 1150$ sq. ft. of heating surface required.

If you use 2-in. pipe for the construction of this unit (which, by the way, is rather small), you will require $1150 \div 0.62 = 1860$ lineal feet of pipe (0.62 being the circumference of a 2-in. pipe in feet).

Substitute for Heating Boiler

In the Sept. 15 issue of Power Plant Engineering, on page 954, R. N. D. asks concerning the feasibility and economy of heating the water for a hot water heating system, with low pressure steam from a separate steam heating system. If the supply of low pressure steam is adequate for the purpose, such a system is entirely feasible.

There are two general types of system that may be used; one in which the water is heated in a closed heater, similar in construction to a closed feed water heater or a condenser; and the other in which the water is heated by direct injection of the steam. To proportion such a heater correctly or to determine the steam demand required data as to the amount of heat supplied to the building through the radiators. For want of such data, values may be assumed. Under an average set of conditions, an average water temperature of 160 deg. and a temperature drop through the system of 40 deg. might be assumed. If then the average room temperature is 70 deg., the mean temperature difference is 90 deg. and the heat transfer may be taken at from 180 to 190 B.t.u. per sq. ft. of radiator surface per hour. Inasmuch as there is 13,000 sq. ft. of heating surface, the total heat flow will amount to $13{,}000 \times 185 = 2{,}405{,}000$, or, say, 2,500,000 B.t.u. per hr.

If it is desired to heat the water with steam at atmospheric pressure, consequently at a temperature of 212 deg. F., the mean temperature difference in the heater will be $212 - 160 = 52$ deg. For this range of temperature, where the velocity of the water over the heating surfaces is not great, the coefficient of heat transfer may be taken as 200 B.t.u. per sq. ft. per deg. per hr. For each square foot of surface then, the heat flow will amount to $52 \times 200 = 10{,}400$ per hr. Inasmuch as 2,500,000 B.t.u. has to be transmitted per hour, the surface required will be $2{,}500{,}000 \div 10{,}499 = 249$ sq. ft. The heater tank then need only be large enough to accommodate this amount of tube surface.

If there is no oil in the exhaust steam, it would perhaps be more efficient to heat the water by injecting steam directly into it. The heat available from steam at atmospheric pressure, for heating water at 160 deg. F. is $970.4 + 212 - 160 = 1022.4$ B.t.u. As 2,500,000 B.t.u. has to be supplied per hour, the steam requirements will amount to $2{,}500{,}000 \div 1022.4 = 2{,}440$ lb. per hr. To condense this amount of steam with a 40 deg. rise in the circulating water would require a flow of approximately 125 gal. per min.

Steam Consumption of a Dry Kiln

We contemplate installing a brick drier in which there will be 19,000 ft. of 1-in. pipe and 5000 ft. of various other sizes ranging from 1¼ to 4 in., but mostly 1¼ in. Using saturated steam at 30 lb. gage pressure, what boiler capacity would be required to supply the steam that can be condensed in these coils? G. S.

A. In order to determine the amount of steam that can be condensed in these coils, it is first necessary to find the amount of heat radiated from the coils to the surroundings and in order to find this quantity, the average temperature of the air in the drier must either be known or assured. Assuming the drier temperature to be 175 deg. F., then with a steam pressure of 30 lb. gage and a corresponding steam temperature of 275 deg. F., the temperature difference is 100 deg. F. As an approximation, it may be assumed that for this temperature range the coefficient of heat transfer will amount to 2 B.t.u. per sq. ft. of pipe surface, per degree difference in temperature per hour.

The external surface of a 1-in. pipe amounts to 0.344 sq. ft. per ft. of length, and that of the 1¼-in. pipe, 0.435 sq. ft. per ft., hence the total pipe surface is $0.344 \times 19{,}000 + 0.435 \times 5000 = 6540 + 2170 = 8710$ sq. ft. The total heat transmission is then $2 \times 100 \times 8710 = 1{,}742{,}000$ B.t.u. per hr. As one boiler horsepower is equivalent to the evaporation of 34.5 lb. of water per hr., from and at 212 deg. F., under which conditions 970.4 B.t.u. are supplied to the water per lb. evaporated, the heat available in a boiler horsepower-hour is $970.4 \times 34.5 = 33{,}500$ B.t.u. approximately. As 1,742,000 B.t.u. has to be supplied, the boiler capacity required is $1{,}742{,}000 \div 33{,}500 = 52$ boiler hp.

Covering Ammonia Line in Service

In the issue of Nov. 1, F. B. O. asks for information on covering his ammonia suction line. In order to put any kind of covering on this line, it is, of course, necessary that the pipe be thoroughly defrosted and dried. If, as it is stated, it is impossible to shut down the system long enough to melt the frost off the line and to dry it off, it will be necessary to install a temporary suction line bypassing the regular line so that the suction vapors may be diverted from it long enough to allow its being dried out and covered.

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CONTENTS

Ohio Plant Operates at Two Pressures. Illustrated.....1117

Use of Performance Data in Boiler Operation. By Edward K. Tomita. Illustrated.....1124

Standardization of Engine Stops. By Walter Greenwood....1126

Mechanical Atomization of Fuel Oil—I. By Claude C. Brown. Illustrated.....1130

Examples in Building Up Boiler Efficiency. By R. C. Demary. Illustrated.....1133

The Best Speed for a Belt. By W. F. Schaphorst. Illustrated.....1134

Lubricating the Eccentrics. By A. R. Knapp. Illustrated....1135

Constructing the World's Largest Power Station. Illustrated.....1136

Principles of Alternating Current Control. By Gordon Fox. Illustrated.....1138

Inductive Alternating Current Circuits—II. By E. K. McDowell.....1142

The Inquiring Engineer.....1144

Foundations for Small Engines and Motors. Illustrated....1146

Oil Used to Heat 9-Story Garage. By C. W. Geiger. Illustrated.....1148

Pipe Wall Thickness Chart. By Dwight Gerber. Illustrated.....1149

Letters Direct from the Plant: Gaskets and Packings, and How to Use Them. Loose Set Screws. Result of Water in the Cylinder. Packing a Conical Stuffing Box. Special Clamp Jig for Bushing Work. Tuning Up Corliss Engines. A Soldering Kink. Illustrated.....1150

Problems in Operating Power Equipment: Live Steam Cools Hot Turbine. Would an Economizer Be Practical? Substitute for Heating Boiler. Steam Consumption of a Dry Kiln. Covering Ammonia Line in Service.....1154

Editorial: Load Factors. Management and the Engineer. Develop Your Sense of Observation.....1156

Steinmetz, "Off Duty".....1157

Another Electrical CO_2 Recorder Is Developed. Illustrated..1158

Power Driven Wire Brush Facilitates Cleaning. Illustrated..1159

New $20,000,000 Station for New Jersey Is Under Way.....1159

Temperature of Electric Solder Pot Controlled Automatically. Illustrated.....1159

Bucket Can Be Dumped by Crane Operator. Illustrated.....1160

Drum Plant on the Bear River to Be Enlarged.....1160

Scientific World Loses Great Leader in Death of Steinmetz. Illustrated.....1161

Founder of Strong, Carlisle & Hammond Co. Dies.....1161

Annual Meeting of A. S. M. E. to Cover Power Subjects....1162

Metropolitan Section of A. S. M. E. Makes Plans for the Year.....1162

American Society of Refrigerating Engineers to Meet Dec. 3..1162

Superpower Conference Addressed by Secretary Hoover....1163

News Notes.....1163

Catalog Notes.....1164

Load Factors

Peak loads are upon us. During the next three months lighting demand will be maximum both as to number of lights used and length of daily use. Also will come the maximum activity in many industries, calling for additional motor power, which will be added to the lighting peak.

But peaks and hollows in the load line are bad for efficiency and economy of the power plant, as they require extra equipment capacity which has long idle periods and obstruct the operating of equipment at its point of best performance.

Some load fluctuation is unavoidable, but much can be done to level the load line by studying the use made of power. In many cases, daily routine can easily be changed so that large demand for motor power will be shifted off the maximum lighting load period. In an individual factory plant this can be done by securing the co-operation of the manager and foreman. In a central station, it requires customer co-operation and an incentive to secure it, which may be a lower rate for off peak use of power or a rebate to the customer for maintaining a high load factor in his own plant.

This will help trim something off the peaks and fill it into the valleys of the load line. And additional cutting of peak load can be accomplished by routine inspection to insure that light is used efficiently where needed and that no unused areas are lighted or idle motors and shafting allowed to run during the peak period. Of course, these precautions ought to be taken at all times to secure lowest factory costs, but they complicate the power plant problem more when neglected so as to increase peak load.

These ideas are not new. Most good ideas are not. But at this season it is well to study whether they are being utilized so as to get the most benefit from them.

Management and the Engineer

When the criticism is advanced that engineers do not appreciate the executive viewpoint and do not make good managers, one of the stock refutations has been to point out many engineers who are heads of public utilities and manufacturing enterprises. There are indeed many such illustrations which might be cited, but is this any criterion that engineers of the future will take a proper share in management?

In the early days of public utility work, the engineer was the big man because the production and transmission of power, the assuring of reliable and continuous service, were the big problems. Sales were secondary and there was no such problem as public relations. What could be more natural than for the engineer to sit in the managerial or presidential chair?

A study of industrial development will show a similar growth. In the early days of an industry, production was the big item; designing the product, building it and doing both in a way which would permit a sale at a profit. Here also the problems of labor, sales distribution and finance were relatively insignificant.

Quite naturally the engineer took his place in management.

But times have changed. The utility and the manufacturing plant are now stable, going organizations. No longer are the problems purely engineering.

When the board of directors meets, will another engineer be chosen to head the company, to take the reins from the old time engineer who has brought the organization up through the early struggles?

The answer to that question lies with the engineer. If he is to succeed in management, he must add to his engineering qualifications such items as sales ability, contact with the public, financial knowledge and a sound view of labor. To say that the engineer of the next generation will take his place in management because some of the old time engineers have made a mark for themselves is indeed fallacious. Only through acknowledging his deficiencies and setting about to make up for them will the engineer create a place for himself in management.

Develop Your Sense of Observation

Every engineer should cultivate the sense of observation for it is in a great measure the means by which he may learn and so add to his store of knowledge upon which can be built a successful career. A casual glance cannot be made to take the place of true observation; that is to say, it is not sufficiently thorough to give such information as would be required for an analysis of the condition in mind.

To the man who is alert, it is not enough for him to see that a pipe is being laid in a trench, he wants to know what the pipe will be used for. He will move up closer to the workmen and ask questions and make mental notes of the work going on so that his information will be of use in the solution of future problems.

This does not mean that the job you may contemplate must be performed just like one observed at some time in the past; it means rather that the previous job should form the basis of further investigation and analysis so that the new work will be constructed in the most approved manner possible.

This sense of keen observation has been developed to a marked degree by the executive who will walk through a plant and point out conditions which may have been entirely overlooked by the men who are directly associated with the plant day in and day out. In all probability the executive was not born with this sense, but he has developed the habit of not only seeing things but of thinking of them at the same time.

To the young man just getting a start in engineering, there is no better suggestion to be offered than that he be observing and that he study and analyze what he has seen. It will also pay some of the older men in the profession to take a personal inventory of themselves on this score.

Steinmetz, Off Duty

Charles Proteus Steinmetz is "Off Duty." On October twenty-sixth, this master mind of electrical engineering passed into the great beyond for all time, and "the old man of the works," as his associates affectionately called him, will be seen around the Schenectady plant no more. The scientific world sustains an irreparable loss.

But, though Steinmetz is gone, the evidence of his having lived, remains. He leaves behind him a heritage of incalculable worth—a heritage of intellectual riches that will last throughout the ages, for the works of Dr. Steinmetz are of a kind which defy the ravaging hands of time. They will remain long after the more tangible works of man have crumbled to dust and ruin. As long as records of the achievements of man continue to exist, so long will the mathematical masterpieces of Steinmetz serve the needs of Humanity.

Steinmetz was a scientist, but first of all, he was an engineer. He was interested in the practical application of scientific principles to the everyday needs of man. He had no interest in mathematics, for mathematics' sake, but only in its application to the solution of engineering problems. His only creed was that of "service." He took the fundamental laws of nature and with the aid of his wonderful brain, adapted them to the comfort and needs of humanity. And in this, rather than in the material return for his services, he undoubtedly found his reward—in the personal satisfaction of knowing that the results of his efforts were making the world easier to live in. After all is said and done, that is the final test which stamps a man an engineer.

If there is any one thing in the life of Dr. Steinmetz that we must admire more than the high character of the work he turned out, it is the unrelenting courage and persistence with which he attacked the complex problems brought before him. True, he was gifted with no ordinary brain. Indeed, he was endowed with a mind which had a marvelous insight into electrophysics, and which enabled him to solve problems which perhaps nobody else could have done in a like manner, but even for this "master mind," the problems were not easy. He did not "just hit upon" the correct solution. If that had been the case, he would have done nothing worthy of great praise.

The problems which he attacked required great mental concentration, even on his part, and it was only because of his constant and unfailing application to the tasks at hand that he was able to solve them. Where others had given up all hope of solution, Steinmetz would take hold and, with his characteristic determination, carry the problem through to success. At the General Electric Company, in times of discouragement and despair, they always turned to Dr. Steinmetz, and he was never failing with counsel and encouragement. It was this spirit of determination that was probably as much responsible for his success as was the fact that he was endowed with an almost superhuman mind.

His life teaches a great lesson. It shows that achievements, after all, are the real things that make a man great. In spite of tremendous physical handicaps, Steinmetz became the greatest electrical engineer of all time, and earned the respect and admiration of the entire world that knew him. In terms of happiness, that is, as happiness is usually measured in this world, Steinmetz had little indeed to be thankful for. Hunchbacked, dwarfed, and hopelessly crippled, probably nobody ever regarded the man but with a feeling of compassion and pity. Yet he bore up under it all with wonderful courage and fortitude, and never deplored his physical shortcomings.

His poor dwarfed little body will soon be forgotten, but the name Steinmetz, already famous, will become more so as the years go by, and the history of his achievements will adorn the mile posts of electrical progress with undying glory.

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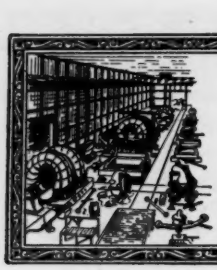
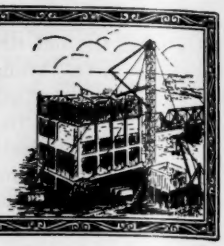


POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS



Another Electrical CO_2 Recorder Is Developed

MEASUREMENT of CO_2 in flue gas by an electrical method, based on the difference in thermal conductivity of various gases, is one which is not new although not much has been done with it in a commercial way until recently. Instruments using this principle have been built in England and one of this type, which is now being distributed in this country, was described

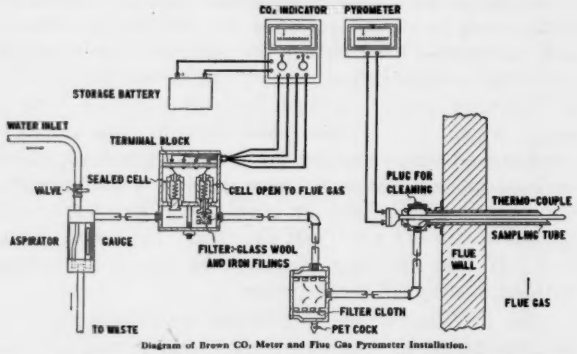


FIG. 1. DIFFERENCE IN THERMAL CONDUCTIVITY OF AIR AND CO_2 IS BASIS OF MEASURING CO_2 ELECTRICALLY

in the Aug. 15 issue. An American manufacturer, the Brown Instrument Co., of Philadelphia, has also taken up the development of this type of CO_2 recorder and several installations have already been made.

As shown in Fig. 1, the essential parts of the Brown system consist of the gas cell assembly which contains the ratio wires, an aspirator for drawing off the gas sample, a filter for removing soot or other foreign matter from the flue gas and an electrical CO_2 indicator, based on the galvanometer principle. In addition, the layout of the apparatus in Fig. 1 also shows a pyrometer although it is merely auxiliary to the CO_2 measurement.

Clean flue gas passes through the gas cell assembly. One of these cells is open so that the flue gas will come in contact with the platinum wire. The other gas cell contains air and is sealed. These two gas cells with their spiral platinum wires make up two legs of a Wheatstone bridge, the other two legs being made up of two balancing resistances which are also a part of the gas cell assembly. Current from the storage battery, controlled to a constant value by a rheostat, passes through these fine wire spirals. Since the thermal conductivity of CO_2 differs from that of air by approximately 40 per cent the wire in the gas cell differs in temperature from the one contained in the air cell. As resistance varies with temperature, the bridge becomes unbalanced and causes a deflection of the CO_2 indicator. It is possible, therefore, to calibrate the deflection caused by varying percentages of CO_2 in the flue gas.

In order to insure equalization of temperature the gas cells are constructed in separate units made of heavy

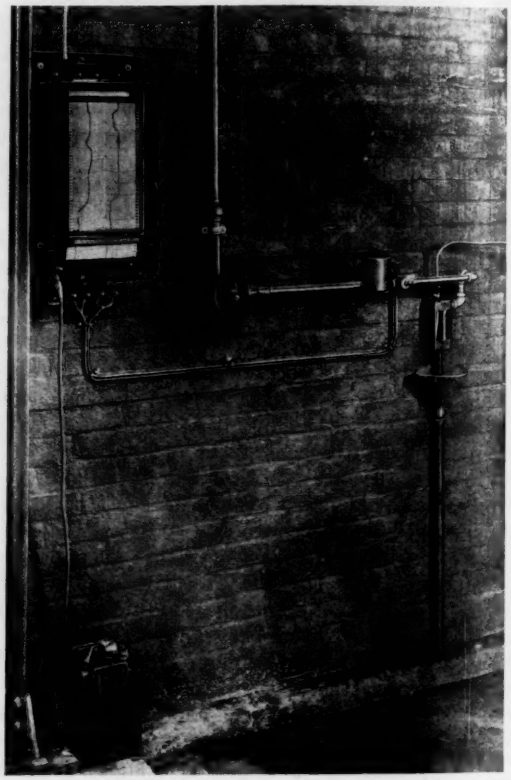


FIG. 2. PER CENT CO_2 AND FLUE GAS TEMPERATURE ARE RECORDED BY THIS INSTALLATION

brass. Both units are removable, being gasketed and secured into place. This construction facilitates the substitution of new gas cells in event of damage. The resistance coils, which are the other legs of the Wheatstone bridge as previously mentioned are also removable.

Water is used for operating the aspirator although only a small quantity is required. If the water supply contains considerable sediment a small filter is placed before the connection to the aspirator. A water level gage indicates the draft in the gas line. If the gas filter becomes clogged, the level will rise due to the increased suction necessary to pull the gas through the filter.

Meters of the type may be either indicating or recording and either form of apparatus can be equipped with an additional scale for measurements of flue gas tem-

perature. In Fig. 2 is shown an installation of the new type of CO_2 recorder in which the recording type of instrument is used, combining both readings of CO_2 and of flue gas temperature.

Power Driven Wire Brush Facilitates Cleaning

TO FACILITATE the cleaning of metal, wood and stone surfaces, the Pilley Packing and Flue Brush Mfg. Co., of St. Louis, Mo., has recently developed a wire brush which may be driven by any convenient method,

BRUSH MAY BE DRIVEN BY DRILL PRESS, LATHE, FLEXIBLE SHAFT OR PORTABLE DRILL

such as a lathe, drill press, portable drill or other such means.

Brushes of this type are made in two principal parts. The holder consists of a ¼-in. shank, suitable for clamping in a chuck, directly connected to a cone in which is fastened the wire bristles while on the outside of the cone is the threaded adjusting sleeve. The adjustment is obtained by turning the hexagon threaded sleeve on the holder. In this way, it is possible to make the wires flexible for light work or rigid for hard work.

New $20,000,000 Station for New Jersey Is Under Way

WORK on the new 205,000-kv.a. station which is being constructed by the Public Service Electric Power Co. for lease to the Public Service Electric Co., of New Jersey, is now well under way. This station, which is at Kearny, Hudson County, N. J., on the Hackensack River between Newark Turnpike and the Lincoln Highway, is to be laid out for an ultimate capacity of 410,000 kv.a. at 80 per cent power factor. The cost of the first section will be $20,000,000.

Three 30,200-kv.a. General Electric Co. turbo-generators and three Westinghouse 43,750-kv.a. units all designed for a throttle pressure of 325 lb. and 271 deg. superheat, or a total steam temperature of 700 deg. F., will comprise the initial installation. The Westinghouse units will have multiple exhaust and are to be bled at three or four points for feed water heating.

Auxiliaries to Be Electrically Driven

All of the auxiliaries, except those provided for emergency service will be electrically driven by current taken from the main generators. Emergency apparatus will include turbine driven boiler feed pumps sufficient in number to keep the boilers on the line without load if service to the electric auxiliaries should be interrupted. In addition, there will be a steam driven circulating pump, cross connected in such a way that it can be used for any one of the five units. There will also be one steam condensate pump for each unit.

Firing will be handled by 16 super-stokers some 17 ft. long with 16 retorts. The furnaces will be unusually large, with high settings and ventilated side walls. Arches over the fire belt and adjacent furnace walls will be so constructed as to permit replacement of fire brick without disturbing the rest of the wall.

Babcock & Wilcox boilers with a rating based on a heating surface of 2360 hp. are to be installed. Superheaters located between two banks of tubes will be used but no provision is to be made for economizers. Boiler feed will be heated to 212 deg. F. in de-aerating type heaters by steam bled from the main units.

Circulating water intakes are to be perpendicular to the river front and each intake will serve two units. The discharge tunnel will be parallel to the river front and discharge at either end into the river, gates, veins or some similar divide will be used to force the discharge of water in the direction of the tide and to prevent it from flowing from the condensers past the intakes and into the condensers again.

One of the features of the coal handling scheme will be the provision for an outdoor storage capacity of 200,000 T.

Temperature of Electric Solder Pot Controlled Automatically

A NEW electric solder pot with automatic heat control has been added to the line of devices manufactured by J. D. Wallace & Co., Chicago. It greatly simplifies the problem of heating babbit, white metal, wax and other materials which are slow conductors of heat.

WHEN TEMPERATURE REACHES 600 DEG. F., CURRENT IS CUT OFF

Solder must be kept at a uniform temperature if satisfactory results are to be obtained. When metal is overheated it oxidizes, and this action results in a considerable loss of material and tensile strength. The solder pot is designed to overcome this oxidation. When solder has been heated to 600 deg. F., an automatic control goes into action. This maintains the temperature of the contents of the pot and prevents overheating and underheating.

This control is an adaptation of the principle used in the steam gage. A volatile substance, which is sensitive to heat, actuated a Bourdon tube which makes and

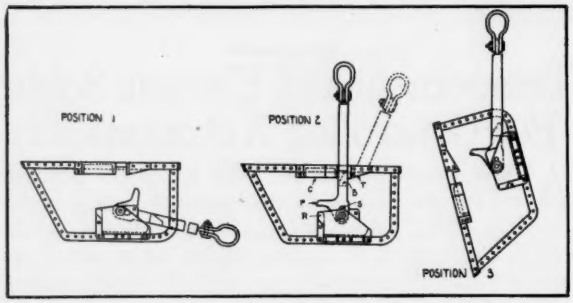
breaks the electric current, thus controlling the temperature of the contents of the pot.

The pot will accommodate 15 lb. of solder and will heat this amount to 600 deg. F. in 20 to 25 min. This quick action is due to the fact that a 900-w. heating element is built around the entire container. Heat is applied to all parts of the sides and bottom of the container simultaneously, thus coming in contact with the solder at all points, and reducing it to a working consistency.

Bucket Can Be Dumped by Crane Operator

IN A NEW type of manually loaded dump bucket, the necessity for a man following the bucket to dump it is eliminated as the bucket is so arranged that the crane operator can perform this function from his position on the crane.

As shown in the accompanying illustration, position 1 of the bucket with bail down is the loading position.



THREE POSITIONS OF BUCKET DURING THE LOADING, LIFTING AND DUMPING OPERATIONS

In position 2, the bucket is ready for lifting. This is accomplished by moving the crane so that the bail will go up against the stop "C." Then the bail may be raised which causes the block "B" to go up into the slot between the stop "C" and the tipper cam "T," which will prevent the bucket from tipping. The bucket can then be carried to any place for dumping. Note the slotted opening in the bail ends marked "S." The bail is attached to the bucket by heavy trunnions.

Position 3 shows the bucket in position for dumping. In order for the crane operator to dump the bucket, he merely lowers it to the place of dumping, then slackens the cable to allow bail to lower in the slot. The bail is then tilted into the position shown in dotted lines by the projection P or the bail coming in contact with a stop just beneath the tripper projection. The operator then moves the crane slightly and pulls upward, which permits the bucket to dump its load.

In order to hook up bail again, it is necessary to set the bucket down and without taking up too much of the slack rope move the crane forward enough to allow the bail to come up against the stop "C"; then raise vertically again, which allows the block B to come up between stop "C" and tripper cam "T" thus preventing the bucket from dumping.

It is not required that a level place for dumping the bucket be selected, as it will operate from almost any inclination or position.

This bucket was developed by J. W. Forsythe, assistant chief engineer of the Carnegie Steel Co., Braddock, Pa., and is manufactured by Jno. D. Hiles Co., of Pittsburgh.

Drum Plant on the Bear River to Be Enlarged

DURING 1922, the engineering department of the Pacific Gas & Electric Co. made a survey of the South Yuba-Bear River system and recommended certain increases in capacity. As a result, a third generating unit was placed in Drum power house, which now has an installed capacity of 50,250 hp., and in the construction program for 1923, further improvements are provided for. Work now to be undertaken includes the raising of the dam at Lake Fordyce, which lies amid the granite peaks about 7 mi. by trail from Cisco, the nearest point on the overland route of the Southern Pacific. The first dam was built there as far back at 1873, and the present dam dates from 1881, though it has been subjected to some reconstruction and reinforcement work since then. It is a rock-filled structure about 800 ft. long, 140 ft. thick at the base and 92 ft. high, and the reservoir thus created is of 20,000 acre feet storage capacity. By raising the dam 47 ft. Lake Fordyce will be transformed into a 47,000-acre feet reservoir.

Meanwhile it will be necessary to reinforce and improve the water transmission facilities between Lake Fordyce and Auburn, in order to take care of the peak load. Improvements will be made in the Drum and Bear River canals, enlargements made where necessary, the alinement rectified in places, certain detours of first construction eliminated and leakage corrected. Drum power house will be improved by the laying of a second penstock down the 1375-ft. incline. About a half mile below Drum a reservoir or a forebay will be built in the Bear River gorge in order to utilize and regulate the water from that plant's "peaking" operations. It is contemplated, also, to enlarge the forebay at the Halsey plant.

Philadelphia Electric Plans Further Expansion

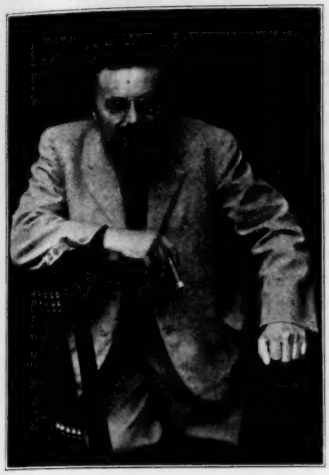
IN ORDER to take care of growing service requirements, the Philadelphia Electric Co. recently purchased a 56-acre tract for $570,000 at the foot of Erie Ave. and the Delaware River, where a new plant will be built. It is expected that about $6,000,000 will be spent on this plant, which will have an initial capacity af about 50,000 kw. According to present plans, work will be started early next year and the plant is expected to be in operation by 1925.

Work on the addition to the Delaware station is proceeding in good shape, as a 30,000-kw. unit was recently placed in service and another is expected to be in operation by Dec. 1. With the unit which has just been added to the Delaware station, the system generator capacity totals 379,845 kv.a.

It is expected that the budget for 1924 will run above $15,000,000, so great are the demands for service.

Scientific World Loses a Great Leader in Death of Steinmetz

ON October 26, the death of Dr. Charles P. Steinmetz shocked the engineering and scientific world because it marked the passing of a man, practically in the prime of life, who has played a leading part in the development of electrical theory and its application to the problems of everyday life. His death was indirectly due to physical breakdown caused by overexertion in his work and by the effects of a recent trip to the Pacific Coast. The direct cause of his death was heart failure.



Charles Proteus Steinmetz was born April 9, 1865, at Breslau, Germany. he was educated at the gymnasum (high school) and then the University of Breslau, where he studied mathematics and astronomy, then physics and chemistry, and finally took a short course in medicine and national economy. Involved in the social democratic agitation against the government, he escaped to Switzerland in 1888, and there studied mechanical engineering at the Polytechnische, Zurich.

In 1889 he came to America, virtually penniless, and found a position with the Osterheld & Eichemeyer Manufacturing Co., first as draftsman at $2 a day, then as electrical engineer and designer, and finally on research work in charge of the Eichemeyer laboratory.

With the absorption of the Eichemeyer interests by the General Electric Co., Dr. Steinmetz was attached to H. F. Parshall's calculating department in Lynn, Mass., and with the transfer of the company's headquarters to Schenectady in the spring of 1894, Dr. Steinmetz organized and took charge of the calculation and design of the company's apparatus, and of the research and development work. For a number of years, Dr. Steinmetz was Professor of Electrical Engineering at Union University, and at the time of his death was Professor of Electro-physics at Union University, at the same time retaining his connection with the General Electric Co. as chief consulting engineer.

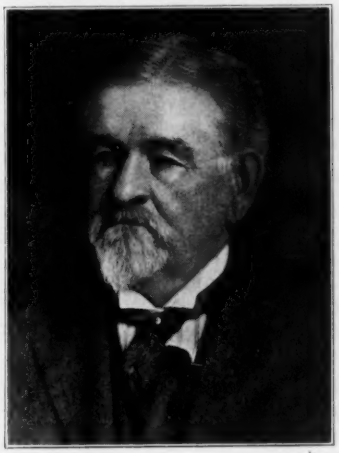
Although a smaller number of patents are credited to his name than to Edison and others, it was the scientific principles discovered by Dr. Steinmetz that made many inventions possible. His "Theory and Calculation of Alternating Current Phenomena," published in 1897, created a marked sensation in engineering circles and revealed a new field. As a valued contributor to engineering journals, his investigations and theories have proved highly instrumental in furthering electrical progress. Most of his papers and discussions have appeared in the Transactions of the A. I. E. E. Among the books published by Dr. Steinmetz are: "Theoretical Elements of Electrical Engineering" (1901), "Theory and Calculation of Transient Electric Phenomena and Oscillations" (1909), "General Lectures on Electrical Engineering" (1908), "Radiation, Light and Illumination" (1909), "Engineering Mathematics" (1911), "Electric Discharges, Waves and Impulses" (1911), "America and the New Epoch" (1916), "Theory and Calculation of Electric Circuits" (1917), "Theory and Calculation of Electrical Apparatus" (1917).

Dr. Steinmetz' special field, in which he was most expert, included magnetics, symbolic method of alternating-current calculations and transient phenomena.

Dr. Steinmetz was Past President of the National Association of Corporation Schools, Vice-President of International Association of Municipal Electricians, Honorary President of International Electrical Congress, Past President of the A. I. E. E., Honorary Member of the N. E. L. A., Fellow of the A. A. A. S., Member of the (British) Institution of Electrical Engineers, Member of the American Mathematical Society, of Quaternion Society, the A. S. M. E., Electrochemical Society, Illuminating Engineering Society, Physical Society, and the American Philosophical Society.

Founder of Strong, Carlisle & Hammond Co. Dies

EDGAR E. STRONG, founder and for 36 yr. head of the Strong, Carlisle & Hammond Co., Cleveland, died Oct. 29. Mr. Strong was born near Manchester, Conn., April 14, 1841. He was educated in the district schools and in the church school of Greenwich, Conn. In 1862 he enlisted with the Sixteenth Connecticut Volunteers for the Civil War, and was engaged in the battle of Antietam in less than 30 days after the formation of the regiment.



Rising from the ranks he was made a second lieutenant on Christmas Day of 1862, and later first lieutenant. The last 11 mo. of the war he spent in seven different southern prisons.

After a year at home recovering from the effects of his confinement, Mr. Strong came to Cleveland on a visit. He became connected with the W. Bingham Co., where he remained for 20 yr.

With N. G. Browne, he organized a lumber business. The venture was wiped out when the yard nearly floated away in the spring floods of 1885 and the balance was destroyed by fire during that summer. Two years later a partnership with R. H. Carlisle and W. J. Turney was formed. The new firm sold mill supplies.

L. J. Hammond took the place of Mr. Turney within a short time, and the present firm of Strong, Carlisle & Hammond had its beginning. A son, Herbert W. Strong, is now a member of the firm.

Annual Meeting of A. S. M. E. to Cover Power Subjects

VISITORS from all parts of the country will attend the Forty-fourth Annual Meeting of the American Society of Mechanical Engineers to be held in New York City on Dec. 3-6, and an elaborate program of general and technical sessions and social events is in preparation for the occasion. Of special interest will be the joint meeting with the A. S. C. E. and the A. I. E. E. on the evening of Dec. 5, when the subject of hydroelectric power will be discussed by three speakers, the principal address being made by John R. Freeman, past president of both the A. S. M. E. and the A. S. C. E. On the morning of Dec. 4, a joint technical session will be held with the A. S. R. E., which is holding its annual meeting simultaneously. The Power Show will also be in progress every afternoon and evening of the week, and in order to avoid conflict with it so far as possible, the sessions of the Annual Meeting which will appeal most directly to power engineers have been assigned to the morning hours.

Of the sixteen technical meetings to be held, three under the management of the Power and Fuels and Material Handling Divisions will be of special interest to power plant men. One of these will take the form of a symposium on coal storage; a second, on heat cycles with reference to the latest practice; while a third will be devoted to the discussion of papers dealing with water measurement.

Among the noteworthy papers to be presented, the plans call for the following: A Graphical Study of Journal Lubrication, by H. A. S. Howarth; Factors in the Spontaneous Combustion of Coal, by O. P. Hood; Coal Handling and Coal Storage, by H. E. Birch and H. V. Coes; Economy Characteristics of Stage Feed Water Heating by Extraction, by E. H. Brown and M. K. Drewry; High Pressure, Reheating and Regenerating for Steam Power Plants, by C. F. Hirschfeld and F. O. Ellenwood; Reheating in Central Stations, by W. J. Wohlenburg; Margins of Improvement in Central Station Steam Plant, by E. L. Robinson; Boiler Plant Economics, by N. E. Funk and F. C. Ralston; Boiler Test Results with Preheated Air, Colfax Station, by C. W. E. Clarke; Economic Status of the Oil Engine, by L. H. Morrison; Salt Velocity Method of Measuring Water, by C. M. Allen and E. A. Taylor; and The Gibson Method and Apparatus for Measuring the Flow of Water in Closed Conduits as Applied in Testing the Efficiencies of Water Wheels in Hydroelectric Power Plants, by N. R. Gibson.

The Special Research Committee on Fluid Meters will hold an open meeting for discussion of Part II of its report. Public hearings will also be held on the Power Test Code for Locomotives.

Following is a tentative list of events of the meeting day by day:

Monday morning: Council Meeting, Local Sections Conference. Evening: Presidential Address, Award of Medals, Reception.

Tuesday morning: Joint Session with A. S. R. E., Textile Session, General Session, Special Research Committee on Fluid Meters. Afternoon: Business Meeting, Public Hearing on Power Test Codes. Evening: Smoker and Dinner, Ladies' Bridge.

Wednesday morning: Fuel, Railway, and Ordnance Sessions. Afternoon: Session on Forest Products, Conference of Committee on Education and Training, Steam Table Research, Ladies' Tea. Evening: Joint Session with A. S. C. E. and A. I. E. E. on Hydroelectric Power.

Thursday morning: Power, Machine Shop, and Aereonautic Sessions. Afternoon: Management Session, Session on Water Measurement. Evening: Dinner Dance.

Metropolitan Section A. S. M. E. Makes Plans for Year

TENTATIVE arrangements for the Metropolitan Section of the American Society of Mechanical Engineers indicate a series of meetings of exceptional interest during the year, beginning in October. Aside from the annual meeting of the society on Dec. 3—6, and joint meetings with the A. S. C. E. and A. I. E. E. on Jan. 9, Feb. 27, and March 19, with subjects to be announced later, the proposed list of dates and subjects of meetings is given below. Except as noted, all meetings will be held at the Engineering Societies Building in New York City.

November:
- 8—Condenser Tubes.
- 20—Powdered Coal.
- 28—Machine Shop Meeting—Newark.

December:
- 18—Low Temperature Distillation.

January:
- 15—Advanced Practice in Ball and Roller Bearing.
- 22—Coal Storage.
- 28—Pressed Metal vs. Die Castings—Brooklyn.

February:
- 14—Rigid Airships.

March:
- 5—Textile Meeting—Paterson.
- 11—Diesel Engine vs. Steam Engine for Industrial Plants.
- 24—Welding Meeting—Newark.

April:
- 1—Boiler Furnace Design.
- 15—Railroad Meeting.
- 29—Special Engineering Features in Laundries and Bakeries.

American Society of Refrigerating Engineers to Meet Dec. 3

FROM Dec. 3 to 5 the American Society of Refrigerating Engineers will hold its annual meeting in New York City, with the usual program of business, professional and social features. There will be one joint meeting with the A. S. M. E., scheduled for the morning of Dec. 4, with papers on "Heat Transfer for Fluids Flowing Inside Pipes" and "The Economical Thickness of Insulation in Refrigerator Cars."

A tentative list of other subjects to be discussed at the meeting includes: Application of Refrigeration in the Dairy; Refrigeration and Air Conditioning in the Bakery; Electricity in Automatic Refrigeration; Additional Data Regarding the Reliability of Fluid Meters in Refrigerating Tests; Underfeed Stokers; Notes on the Design of Automatically Controlled Refrigerating

Plants Rules and Formulas for the Refrigerating Engineer; Steam Boiler Developments; Specific Heat of Superheated Ammonia Vapor; and Cost of Electrical Power: Rates and Rate Control.

Superpower Conference Addressed by Secretary Hoover

PUBLIC SERVICE officials of eleven states comprising the New England and Middle Atlantic sections met in conference with Secretary of Commerce Hoover at the Engineering Societies Building, New York City, on Oct. 13. The conference was of a preliminary nature, being the first step toward evolving means by which effective co-operation can be brought about between the federal government and the states concerned looking toward comprehensive development of a superpower system in this section of the country irrespective of state boundaries. Arrangements were made for calling a later conference within a month or six weeks, the scope of which will be enlarged by inviting representatives of public service companies and of various interested civic organizations.

William E. Murray and E. S. Buckland of the Federal Superpower Commission of 1918, M. H. Aylesworth, manager of the National Electric Light Association, and O. V. Merrill of the Federal Power Commission attended the conference. Among the state officials present were William A. Prendergast, Chairman of the New York State Public Service Commission; William E. Guerney, Chairman of the Maine Public Service Commission; William T. Gunnison, Chairman of the New Hampshire Public Service Commission; Commissioner Stone of the Massachusetts Department of Public Utilities; William C. Bliss, Chairman of the Rhode Island Public Utilities Commission; Richard T. Higgins, Chairman of the Connecticut Public Utilities Commission; Harry V. Osborne, Chairman of the New Jersey Public Service Commission; William D. B. Ainey, Chairman of the Pennsylvania Public Service Commission; and Ezra Whitman, Chairman of the Maryland Public Service Commission.

It was estimated by Secretary Hoover and by Mr. Murray that the savings consequent to an outlay of $1,250,000,000 for putting the proposed superpower system into effect will amount to over $500,000,000 annually. In carrying out the plan, it will be necessary to secure agreement and wholehearted co-operation on the part of the political units involved.

News Notes

BOILER-KOTE CO., 608 South Dearborn St., Chicago, Ill., will be known in the future as the Maphite Corporation.

CHARLES P. TOLMAN has resigned as chief engineer and chairman of the Manufacturing committee of the National Lead Co., a position he has held for the past 16 yr., to take up consulting work, with offices at 111 Broadway, New York City. He will continue as consulting engineer for the National Lead Co. and in addition will specialize in dust and fume control, handling materials and products, and in manufacturing methods and processes.

TO FACILITATE and expedite the transaction of business, the Quaker City Rubber Co., of Philadelphia, will move all departments of the organization to its factory at Wissinoming, a suburb of Northeast Philadelphia.

WALTER. E. GILLHAM announces that Benjamin F. Cook and W. Emery White, both of whom have been associated with him for a number of years, are now members of the firm, which will hereafter be known as Gillham, Cook & White, consulting engineers, Kansas City, Mo.

FOUNDATIONS are now being laid for a new generating station, adjacent to the boiler room, at the Battle Creek Sanitarium, Battle Creek, Mich. Plans are in the preliminary stages, as the equipment has not been selected although it is expected that a turbine will be installed.

JAMES F. MUIR is now engineer in the Mechanical Division of Stone & Webster, Inc., in the Boston office. Following his service in the army during the war, Mr. Muir was superintendent of mechanical equipment for the Minnesota & Ontario Paper Co. at International Falls, Minn., and left that organization to become supervising mechanical engineer with Toltz, King & Day, Inc., Engineers of St. Paul, Minn.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., at its South Philadelphia Works, has established a general engineering division which will be devoted to the study of central station and industrial plant problems, which involve the application of steam power apparatus such as steam turbines, condensers and reduction gears. This department will also co-operate with the sales organization in providing engineering service to purchasers of this equipment.

ROANOKE RAPIDS (N. C.) POWER CO. has awarded a contract to Stone & Webster, Inc., of Boston, Mass., for the construction of a new brick and steel power station on the Roanoke River. The equipment will consist of a 3200-hp. water wheel for 300 ft. net head, direct connected by a vertical shaft to a 3000-kv.a. generator. The work also includes enlarging the existing canal and altering the present head works.

AN ARRANGEMENT has been effected between the Wellman-Seaver-Morgan Co. of Cleveland and Akron, Ohio, and the Newport News Shipbuilding and Dry Dock Co. of Newport News, Virginia, whereby the latter company has taken over the future hydraulic turbine business of the Wellman-Seaver-Morgan Co. The staff of the Shipbuilding Co. will be re-enforced by the additional engineering talent they have acquired from the Wellman-Seaver-Morgan Co.

JOHN A. GRIMMONS, an assistant engineer for the Malden Electric Co., one of the Charles H. Tenr y companies, was killed at the sub-station of the company in Everett, Mass., while Mr. Grimmons was explaining the use of some new apparatus to a party of 30 engineers. He had opened a switch on a high power wire carrying 22,000 v. and in explaining it, reached his hand toward the switch. The current jumped to his outstretched hand.

HENRY L. DOHERTY is to be chairman of the board and president of the Public Service Co., of Colorado, which is a merger of the Denver Gas & Electric Light

Co. and the Western Light & Power Co. A new plant is now under construction at Valmont which will be the main source of energy supply for the entire district between Denver and the Wyoming line. The first section of plant is to be 20,000 kw. although the ultimate capacity is expected to be about 200,000 kw. According to present plans, the first section will be in operation by July of 1924.

Western Maine Power Co. has purchased the plant of the Fryeburg Electric Co., at Fryeburg, Me. The new owners have already started the construction of a power plant on the east side of the Saco River at Swan's Falls, Me.

Construction of the first section of a 60,000-kw. plant of the Peoples Power Co., at Moline, Ill., will be started this fall, according to present plans. The plant will be located on the Illinois side of the Mississippi River. The first section will be 10,000 kw.

Foundations are being put in for the hydroelectric power plant for the Lake Sunapee Power Co., at Sunapee, N. H. The concrete dam, power house and other buildings will cost $40,000 exclusive of equipment. Contracts for the water wheels have been let to S. Morgan Smith, of York, Pa., and for electrical equipment to the General Electric Co., of Schenectady, N. Y.

Putnam Woolen Co., of Putnam, Conn., has started the construction of a brick power house, waterwheel, electric generator and other equipment for hydroelectric power for its mills. The plant will have a capacity of 375 hp. The present waterwheel has been in use by the company since 1872. The company will install individual motor drives when the new plant is completed.

Keene Gas & Electric Co., of Keene, N. H., is building a hydroelectric power plant at Marlboro, N. H., and the walls are up and roofing in of the plant has commenced. In connection with this work, a concrete dam 150 ft. long and 60 ft. high is under construction, a wood stave pipe line 5600 ft. long and 4 ft. in diameter and the brick and concrete power house will bring the cost of the development to approximately $300,000 without equipment.

Catalog Notes

Water filters and filtration equipment are covered in bulletin 105 published by the Permutit Co. of New York City. The bulletin takes up a discussion of the various problems to be considered in the subject of filtration and goes on to show how the various types of Permutit filters meet these conditions.

Heavy duty direct current motors are covered in bulletin No. 2014, recently issued by the Reliance Electric & Engineering Co., of Cleveland, O. Complete construction details of this line of motors, which is known as the type T, are presented in the bulletin. Illustrations are also shown which give an idea of typical installations of these motors.

Noark Universal Service Switches are described in catalog No. 53 issued by the Johns-Pratt Co., of Hartford, Conn. This switch combines, in one enclosed unit, the functions of a service entrance switch and cut-out block with facilities for meter connection and testing. A folder also issued by the organization covers the Noark service blocks. This service box is both a cut-out and switch in one device. When the cover is opened, the circuit is automatically opened by the withdrawal of the fuses.

Bass Foundry & Machine Co., of Ft. Wayne, Ind., has recently issued bulletin BD describing horizontal return tubular boilers. Construction details of the boilers are illustrated and the ratings and dimensions tabulated.

Tachometers, both indicating and recording, as made by the Bailey Meter Co., of Cleveland, Ohio, are the subject of its Bulletin No. 200. The instrument itself, arrangement of chain drive, and adjustment for recording or indicating speeds from 3/5 up to 2000 r.p.m. are fully described, with clear sectional drawings.

Super Service Cord and Cable is covered in a bulletin now being distributed by the Rome Wire Co., of Rome, N. Y. The feature of this cord and cable is the outside jacket of rubber which is vulcanized in steel molds under pressure. According to the bulletin, cords and cables of this type are used on portable tools or equipment which are subjected to conditions such as excessive exposure and wear.

Telescopic hoists as used for handling ash cans, barrels, bales and other loads between floors are discussed in a new bulletin now being distributed by Gillis & Geoghegan, of New York City. Telescopic hoists of this type are built so that ash cans may be hoisted from a basement boiler room and dumped into a struck at the street level above. When the hoist is not in use, it may be telescoped below the sidewalk doors.

Gas conditioning for CO_2 recorders is the general subject of bulletin No. 116-A now being distributed by the Uehling Instrument Co. of Paterson, N. J. Since soot, moisture and sulphur are the three natural enemies of the CO_2 recorder, this bulletin takes up three devices which it is claimed eliminate these troublesome elements. These devices are the "Pyro-Porus" filter, a gas drier, and a purifier. The bulletin also illustrates the small bore, seamless drawn tubing used for gas sampling lines.

Refractories and Furnace Design are subjects which are discussed in the new bulletin published by the Jointless Fire Brick Co., of Chicago. Besides presenting some general information on the problems to be met in furnace design, the bulletin also takes up the use of Plibrico furnace lining which is the trade-name for a plastic furnace lining manufactured by this organization. Instructions are given as to the best way for applying a lining and also methods to follow in making repairs to side walls, bridge walls and arches.

Multi-pointer gages as embodied in Bailey meters are described and illustrated in Bulletin No. 161, recently received from the Bailey Meter Co., of Cleveland, Ohio. The bulletin gives details of construction, connections and operation of the low range draft indicator, the differential pressure indicator, the high pressure gage, the indicating flow meter for steam or water, the boiler meter and flue gas temperature indicator. Any or all of these may be combined into a multi-pointer gage having from one to 12 pointers in a single casing.